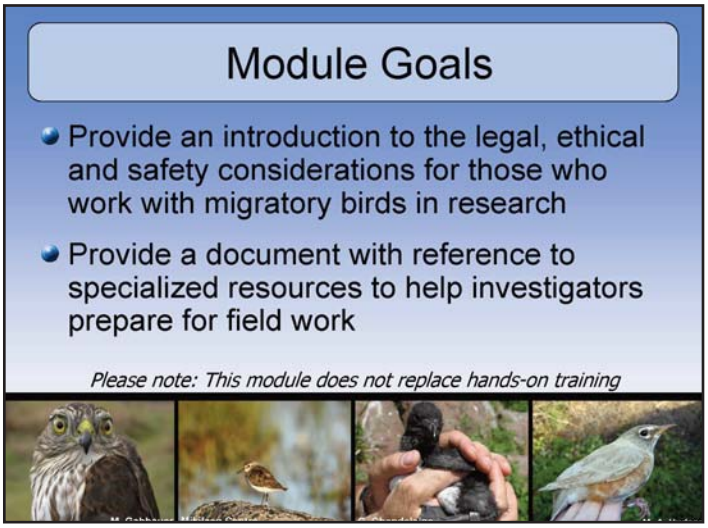
Migratory Birds in Research: Animal User Training

Companion Notes

SLIDE 2



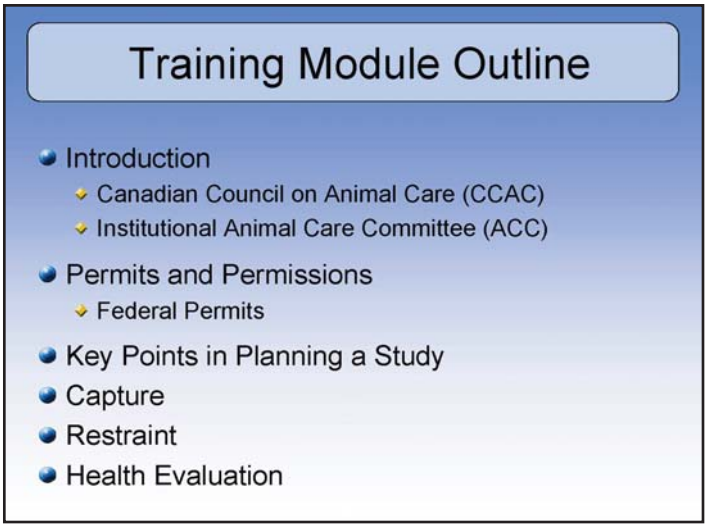
This training module has two main goals:

- To provide an introduction to the legal, ethical and safety considerations for those working with migratory birds in research and conservation. This module outlines the steps to take prior to the commencement of any field study involving wild birds. It represents the *first step* in investigator training, and must be complemented with specialized and practical training.
- To provide a document with reference to specialized texts, guidelines and training manuals for investigators. Internet links have been embedded throughout this module (indicated by underlined text) to provide direct access to some of these texts and guidelines.

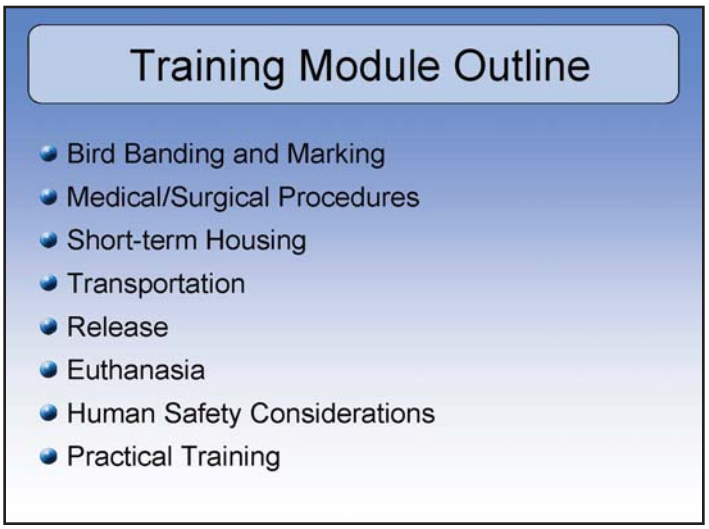
Please note: This module provides only a theoretical introduction to working with migratory birds. It does not replace the necessary competence in field skills that must be acquired through specialized technical training.

References cited in this module are intended to provide direction to further information; however, investigators should consult relevant experts and scientific literature for the most recent information on the species and techniques under consideration.

SLIDE 3



SLIDE 4



SLIDE 5

The Canadian Council on Animal Care (CCAC), established in 1968, is the Canadian organization responsible for setting and maintaining standards for the care and use of animals in research, teaching and testing. The CCAC pioneered the establishment of institutional animal care committees (ACCs), and ensures the fulfillment of the ACCs' responsibilities during CCAC assessments and follow-up visits.

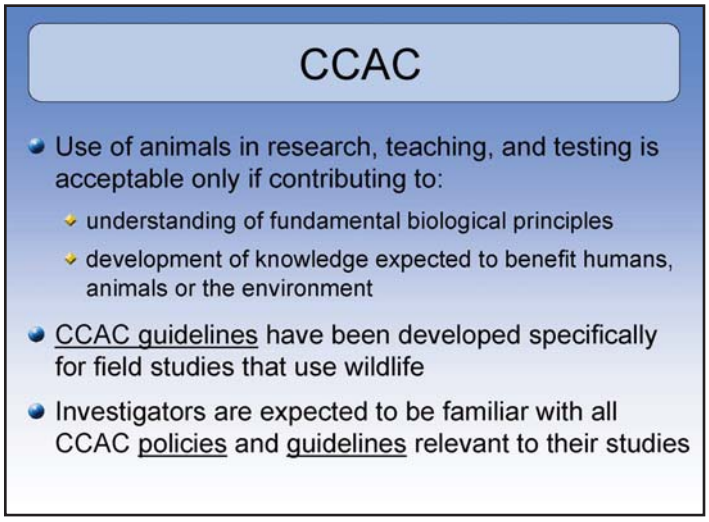
Participants of the CCAC Program include Canadian universities, colleges, hospitals, government, and private sector facilities that use animals in research, teaching or testing.

The CCAC's mission statement highlights the importance of sound ethics when using animals in research:

> "The purpose of the Canadian Council on Animal Care is to act in the interests of the people of Canada to ensure through programs of education, assessment and persuasion that the use of animals, where necessary, for research, teaching and testing employs optimal physical and psychological care according to acceptable scientific standards, and to promote an increased level of knowledge, awareness and sensitivity to relevant ethical principles."

For more information, please visit www.ccac.ca.

SLIDE 6



The use of animals in research, teaching, and testing is acceptable only if it promises to contribute to the understanding of fundamental biological principles or to the development of knowledge that can reasonably be expected to benefit humans, animals or the environment.

Investigators should be familiar with the following CCAC guidelines:

- *guidelines on: the care and use of wildlife*
- *Guide to the Care and Use of Experimental Animals*, vol.1

These and other CCAC guidelines are available at: www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/GDLINES/Guidelis.htm

CCAC policy statements are available at: www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/POLICIES/policy.htm

Additional references:

Animal Behavior Society (1986) Guidelines for the use of animals in research. *Animal Behaviour* 34:315-318.

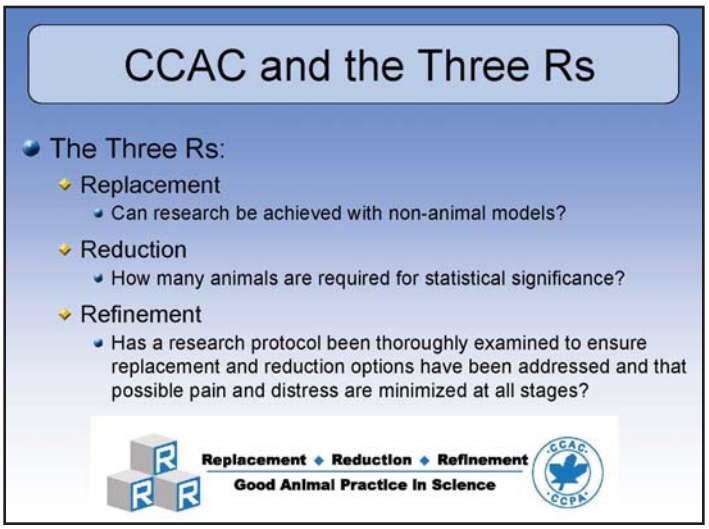
Emlen S.T. (1993) Ethics and experimentation: hard choices for the field ornithologist. *Auk* 110:406- 409.

Friend M., Towell D.E., Brownell R.L.Jr., Nettles V.F., Davis D.S. & Foreyt W.J. (1994) Guidelines for the proper care and use of wildlife in field research. In: *Research and Management Techniques for Wildlife and Habitats*, 5th ed. (ed. T. Bookhoudt), pp. 96-105. Bethesda MD: The Wildlife Society.

Gaunt A.S. & Oring L.W. (1999) *Guidelines to the Use of Wild Birds in Research*, 2nd ed., 66 pp. The Ornithological Council.

Peck F.R. & Simmonds R.C. (1995) Understanding animal research regulations: obligations of wildlife departments and field researchers. *Wildlife Society Bulletin* 23:279-282.

SLIDE 7



Investigators must read and understand the CCAC's *Ethics of Animal Investigation* (www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/POLICIES/policy.htm) and adhere to humane principles when planning research, teaching or testing in the laboratory or in the field.

Research studies using animals must be designed with consideration of the Three Rs of replacement, reduction and refinement in mind. Investigators must understand these terms and their underlying principles, and design their studies accordingly. Although the Three Rs were created for biomedical research, and biomedical and wildlife research are very different, the Thee Rs' principles should still be applied.

The following is an excerpt from I*ncorporation of the principles of the Three Rs in wildlife research* by Griffin & Gauthier (2004):

> **Replacement**: Animals may be used only if the researcher's best efforts to find a replacement by which to obtain the required information have failed.
>
> The *CCAC guidelines on: the care and use of wildlife* encourage formal reporting of results from wildlife studies, and literature review prior to initiating a study, to ensure that animals are not used unnecessarily.
>
> In the context of field studies to understand the ecology, ecophysiology, or behavior of wildlife, replacement by a non-animal method, or even replacement of one species with a less sentient species will likely not be an option. Replacement of a rare or threatened species with a more common species is desirable in terms of conservation impacts; however, it will not affect the welfare implications of the work, as the replacement species is likely to be closely related and of a similar sentience. In addition, research involving endangered or threatened species may be necessary in support of the species conservation or the habitat (Gott, 1999).
>
> **Reduction**: The fewest animals appropriate to provide valid information and statistical significance should be used.
>
> Good study design is the primary means of minimizing the number of animals required to demonstrate experimental outcomes in field studies, as in laboratory-based animal studies. However, field studies often require larger samples than laboratory studies to overcome environmental variation and intrinsic host variability that cannot be controlled in the study. Prior statistical evaluation of sample size is necessary, even when

sources of variation can only be estimated roughly. Familiarity with the literature on similar studies regarding sample size and study design is equally important. Animal use can also be minimized by better sharing of data and publication of results in generally accessible formats. The *CCAC guidelines on: the care and use of wildlife* recommends that, if possible, studies should be designed so that specimens are used for multiple purposes, or so that they can be combined with samples from additional field seasons to maximize the use of specimens. This also includes the collection of biological and genetic samples for archiving whenever possible, providing that this does not increase the concomitant level of pain and distress for the animal.

Refinement: The most humane, least invasive techniques must be used.

The refinement of animal care and use guidelines is a continuous process. It became evident in the generation of these guidelines that investigators frequently adopt practices that are believed to improve animal welfare. These practices are often based on anecdotal evidence, largely unpublished, but passed on through informal training or informal discussions. The *CCAC guidelines on: the care and use of wildlife* recommend that investigators use opportunities to publish refinement techniques to improve welfare outcomes for study animals. Investigators are also encouraged to share their best practices with the CCAC so that these can be subject to peer-review and incorporated into the species specific recommendations as regular updates.

Additional references:

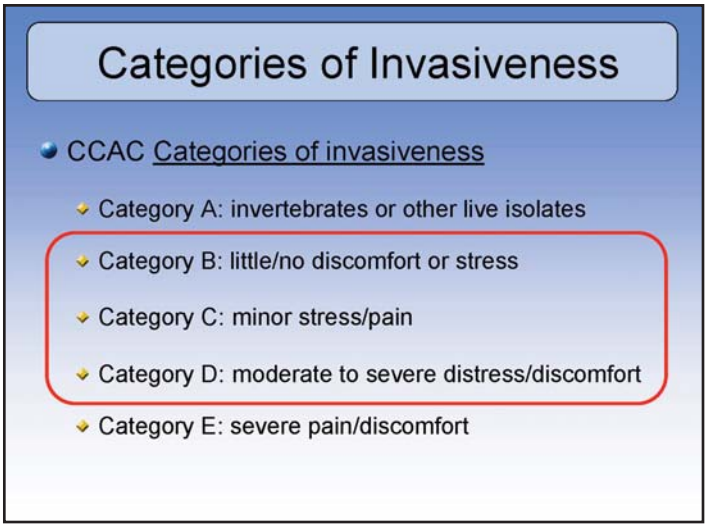
Gauthier C. & Griffin G. (2005) Using animals in research, testing and teaching. *OiE Scientific and Technical Review* 24:735-45.

Griffin G. & Gauthier C. (2004) Incorporation of the principles of the Three Rs in wildlife research. *Alternatives to Laboratory Animals* 32:215-219.

National Centre for the Replacement, Refinement, and Reduction of Animals in Research: www.nc3rs.org.uk

SLIDE 8

The CCAC has designated five categories of invasiveness, from A-E. A description of each category of invasiveness can be found at: www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/POLICIES/CATEG.HTM. This training module deals with research protocols within categories B to D.



The following are examples of experimental procedures which are considered to be representative of each category:

Category A. Experiments on most invertebrates or on live isolates. Possible examples include the use of tissue culture and tissues obtained at necropsy, and studies in which the animals are observed without any disturbance to them.

Category B. Experiments which cause little or no discomfort or stress. Possible examples include: observational studies in which there is some disturbance to the animals but not to the point that individuals habituate or otherwise modify their behaviour; census or other surveys which disturb animals but which do not involve capture or marking individuals; and short periods of food and/or water deprivation equivalent to periods of abstinence in nature.

Category C. Experiments which cause minor stress or pain of short duration. Possible examples include: capture, using methods with little or no potential to cause injury and marking of animals for immediate release; long-term observational studies on free ranging animals where the behaviour of individuals is altered by repeated contact; brief restraint for blood or tissue sampling; short periods of restraint beyond that for simple observation or examination, but consistent with minimal distress; short periods of food and/or water deprivation which exceed periods of abstinence in nature; and exposure to non-lethal levels of drugs or chemicals. Such procedures should not cause significant changes in the animal's appearance, in physiological parameters (such as respiratory or cardiac rate, or fecal or urinary output), in social responses or in ability to survive. **Note**: During or after Category C studies, animals must not show self-mutilation, anorexia, dehydration, hyperactivity, increased recumbency or dormancy, increased vocalization, aggressive-defensive behaviour, or demonstrate social withdrawal and self-isolation.

Category D. Experiments which cause moderate to severe distress or discomfort. Possible examples include: capture using methods that have the potential to cause injury (e.g., net gunning, etc.); maintenance of wild caught animals in captivity; translocation of wildlife to new habitats; major surgical procedures conducted under general anaesthesia, with subsequent recovery (e.g., implantation of internal telemetric devices; prolonged (several hours or more) periods of physical restraint; induction of behavioural stresses such as maternal deprivation, aggression, predator-prey interactions; and procedures which cause severe, persistent or irreversible disruption of sensorimotor organization. Other examples in captive animals include: induction of anatomical and physiological abnormalities that will result in pain or distress; the exposure of an animal to noxious stimuli from which escape is impossible; and exposure to drugs or chemicals at levels that impair physiological systems **(N.B. Experiments described in this paragraph would be Category E if performed on wildlife immediately prior to release)**. **Note**: Procedures used in Category D studies should not cause prolonged or severe clinical distress as indicated by marked abnormalities in behavioural patterns or attitudes, the absence of grooming, dehydration, abnormal vocalization, prolonged anorexia, circulatory collapse, extreme lethargy or disinclination to move, and clinical signs of severe or advanced local or systemic infection, etc.

Category E. Procedures which cause severe pain near, at, or above the pain tolerance threshold of unanesthetized conscious animals. This category of invasiveness is not necessarily confined to surgical procedures, and may include exposure to drugs or chemicals at levels that may markedly impair physiological systems and which cause death, severe pain, or extreme distress; behavioural studies about which the effects of the degree of distress are not known; environmental deprivation that has the potential to seriously jeopardize an animal's well-being; use of muscle relaxants or paralytic drugs without anaesthetics; a euthanasia method not approved by the CCAC; any procedures (e.g., the injection of noxious agents or the induction of severe stress or shock) that will result in pain which approaches the pain tolerance threshold and cannot be relieved by analgesia (e.g., when toxicity testing and experimentally-induced infectious disease studies have death as the endpoint); capture methods with a high potential of causing severe injury that could result in severe chronic pain and/or death.

SLIDE 9

Investigators should be familiar with their institutional animal care committee (ACC) (www.ccac.ca/en/CCAC_Programs/ACCs/Introduction.htm), which is responsible for reviewing all studies involving animals conducted through their institution, regardless of whether the project will be conducted on-site or not.

The ACC must approve each research protocol involving animals as being ethically acceptable before animals can be used. This means that all paperwork relevant to the protocol must be submitted to the ACC before final approval can be given. It is also the ACC's responsibility to ensure that a system is in place to monitor animal use after the protocol has been approved by the ACC. The ACC conducts site visits of all animal facilities, and provides the CCAC with data on the purpose of animal use and the number of animals used by species. It is the investigator's responsibility to consult with the ACC whenever necessary, and to inform the committee of any changes in protocol that may occur during the study. See *CCAC policy statement on: animal base projects involving two or more institutions* (2003), www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/GDLINES/ProjectsInvolvingTwoorMoreInstitutions.htm

SLIDE 10

Once the protocol is developed, and before activities begin, investigators must apply for approval from their institutional animal care committee (as noted in slide 9).

The management of wildlife in Canada is shared by the federal and provincial / territorial governments, often in partnership with landowners and local people. This module reviews

federal permit requirements only. All investigators working with wildlife must contact relevant provincial and/or territorial authorities for additional local permit requirements.

Federal permits are required by those working with birds protected by the *Migratory Birds Convention Act* (MBCA) and the *Species at Risk Act* (SARA). These are detailed in slide 11. Additional federal permits may be required if work is to be conducted on federal lands, if birds or samples are to be transported, or if transmitters or drugs will be used.

Provincial/territorial permit requirements vary with province and territory, the species involved (i.e. the study subjects and any mammalian predators or lure species that are to be trapped according to the protocol, and whether these are protected species) and the activity (i.e. killing, capture, holding, marking, transport, trade, and sometimes release of birds). Permits may also be needed to conduct research in provincial/territorial wildlife areas, refuges, game sanctuaries, ecological reserves, wilderness areas, parks, or other specially designated lands. Permits may also be required for active habitat manipulation or other activities on any provincial/territorial land. Many provinces and territories require permits for the use of firearms. Investigators must apply for the appropriate permits to all provinces and/or territories where work will be conducted.

Both federal and provincial/territorial permits come with reporting requirements that must be fulfilled annually or upon termination of the protocol. All steps taken during the protocol should be carefully documented for clear and comprehensive end-of-activity reporting.

All Band Councils and other landowners must be contacted and asked permission to access private land. Formal applications may be required for access to First Nations land.

If veterinary drugs are to be used in a research project, depending on whether they are currently marketed in Canada, a permit from the Veterinary Drug Directorate of Health Canada may also be required. For more information, please visit www.hc-sc.gc.ca/index_e.html.

If samples or carcasses are to be collected under the protocol, lab biosafety permits (at the necessary biosafety level) should also be acquired. This mainly applies to labs within academic or research institutions; however, in the future government labs will likely be required to hold such permits as well.

SLIDE 11

The Canadian Wildlife Service (CWS) (www.cws-scf.ec.gc.ca/index_e.cfm), Environment Canada, is Canada's national wildlife agency and is responsible for the protection and management of migratory birds and nationally important wildlife habitat, federally listed species at risk, and control of international trade in endangered species.

CWS issues the following permits. More information is available through the links listed as 'Laws, Regulations, Enforcement' and 'National Wildlife Research Centre' on the CWS website.

Scientific Permits: The *Migratory Birds Convention Act* was created to protect all migratory birds, their eggs and nests. Any work using migratory birds requires a scientific permit. Scientific permits to capture and band are required for all bird marking. Scientific collection permits are required for activities such as the collection of live and dead birds, blood or feather collection, clipping nails, egg collection and collection of nest materials.

Species at Risk Permit: The *Species at Risk Act* (SARA) was created to protect designated wildlife species found on federal lands and their critical habitat (i.e. the habitat necessary for the survival or recovery of a listed wildlife species) and identified as such in the recovery strategy or action plan for the species. A SARA permit may be required for those working on federally listed species in addition to the *Migratory Birds Convention Act* permits.

Access to Federal lands: Authorization to work in federal Migratory Bird Sanctuaries or National Wildlife Areas can be requested from the CWS Regional Office.

Hunting Permit: A hunting permit is required if firearms will be used.

CITES Permit: The *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES, www.cites.org) controls the international trade of selected species. All import, export, re-export and introduction of species covered by the Convention has to be authorized through a licensing system. The species covered by CITES are listed in three appendices, according to the degree of protection assigned. The CITES website lists the types of permits required, and provides application forms. Within Canada, the implementation and administration of CITES are shared among federal and provincial/territorial agencies, and therefore both should be consulted.

WAPPRIITA: *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (WAPPRIITA) is the enabling legislation for CITES in Canada. WAP-

PRIITA also provides the authority to protect Canadian ecosystems from the introduction of listed harmful invasive species by requiring permits, and makes it an offence to transport an animal/plant from one province/territory to another or export from a province/territory without the required provincial/territorial permits. CWS is responsible for federal permitting issues, but impacted provinces/territories must issue appropriate permits as well.

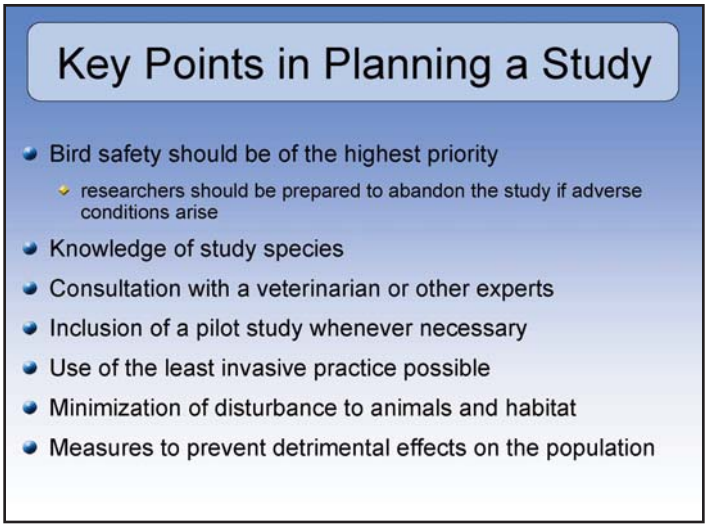
National Parks: The Parks Canada Agency is responsible for protecting and preserving heritage areas for present and future generations. Research and collection permits are required for any research within Canada's National Parks. Information and applications can be found on their website: www.pc.gc.ca.

Industry Canada: If the use of radio transmitters is planned, investigators must contact the regional office of Industry Canada to enquire about licences that may be required.

Canadian Nuclear Safety Commission (CNSC): Formerly, any work involving radioactive isotopes in Canada required a license from the CNSC (www.nuclearsafety.gc.ca/eng/licensees). The specifics of the licensing requirements will depend on the type, activity and use of the isotope. In light of the ever-increasing use of stable isotopes in migratory bird research, these isotopes are no longer subject to this regulation; however, it would be advantageous to use this commission as a resource.

This module covers Scientific Permits, Bird Banding Permits and Species at Risk Permits in detail. For information on other permits, the appropriate authority listed above should be contacted.

SLIDE 12



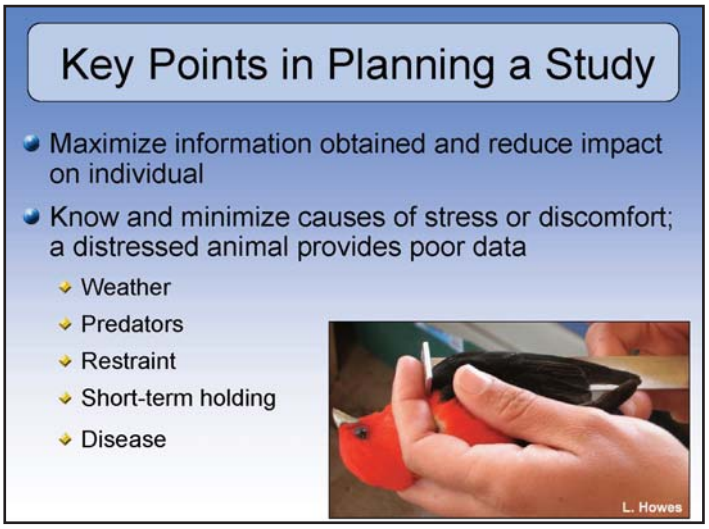
When planning a research project that requires the use of wild birds, it is important to understand that careful treatment of the study subject is not only an ethical consideration but improves the scientific validity of the research data as well. The safety of the birds should be of a higher priority than research considerations wherever possible. Investigators must consider the following points:

- Investigators must understand all factors which affect both the quality of the data collected and the study species, including ecology, biology, migratory behaviour, anatomy and physiology.
- A protocol must be developed in consultation with a veterinarian indicating what to do if the bird is not healthy or is injured (i.e. transport to rehabilitation facility for treatment

and/or euthanasia considerations). Plans should allow adequate time to access certain veterinary drugs, as some of these may require weeks or months to obtain via an Emergency Drug Release from the Veterinary Drug Directorate.

- Investigators should consult with other recognised experts who have field experience with specialized techniques and protocols. Consultation may involve having these experts instruct various techniques (e.g., transmitter attachment , bird handling, etc.) that cannot be taught simply from reading literature.
- Pilot studies that use few animals should be encouraged when new approaches, methods, or products are being tried before large-scale protocols are approved. This will strengthen the project's results by reducing error and attrition.
- Research involving indirect manipulation (e.g., food supplementation or artificial predators) or direct manipulation should use the least invasive practical procedures required to achieve the study objectives, considering the biology and behaviour of the species of interest.
- Activities should minimize disturbance that can lead to nest desertion, abandonment of territories or home ranges, interruption of feeding, disruption of social structures or alteration of predator prey relationships.
- Procedures likely to have lasting negative effects on a population, or that place a population at risk, should not be undertaken except under extraordinary and well justified circumstances.

SLIDE 13



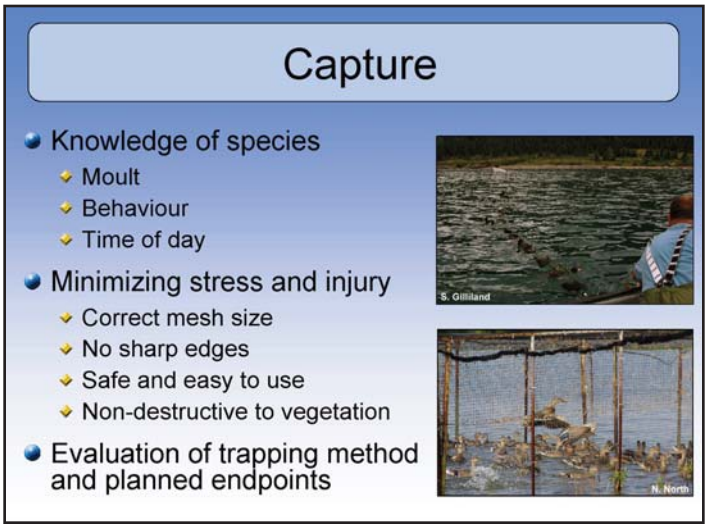
If the investigator must handle wild birds to meet their study objectives, maximizing the information obtained during handling while reducing the impacts on the individual is an **ethical imperative**. In order to reduce these impacts, investigators must know the potential causes of stress or discomfort. These include:

- **Weather**: Certain climatic conditions (e.g., extremes in temperature, humidity and direct exposure to the elements) can result in hyperthermia (high body temperature) or hypothermia (low body temperature).
- **Predators**: In planning trapping and short-term holding, consideration should be given to protection from both aerial and terrestrial predators. Unless required in the field, dogs and other companion animals are not appropriate in a research setting. There are many

ways to reduce the likelihood of predation, some of which include but are not limited to: elevating mist-nets to limit terrestrial predation; checking nets frequently to reduce the likelihood of predation by avian predators; accessing nests via a different route each time to minimize the development of trails leading to the nest site; and discretely marking a nest's location, for example with GPS tracking or natural objects rather than using a colourful flag. Wooden posts should not be used to indicate locations as they may be used as perches for avian predators.

- **Restraint**: Any restraint used should be appropriate to both the study objectives and the species under consideration.
- **Short-term holding**: The method of holding birds should be appropriate for the species, the duration of the research and the study objectives. Short-term holding refers to captivity for less than 24 hours. Captivity greater than 24 hours requires additional permits and husbandry considerations. Additional information is provided in the section on housing.
- **Disease**: Handlers must disinfect their hands, clothing and footwear as often as possible and/or practical to minimize disease transmission between birds.

SLIDE 14



Federal and provincial/territorial permits may be required for capture of migratory birds. Permits must be in hand before capture begins.

The chosen method of live trapping birds must minimize the possibility of injury or death to captive individuals and cause a minimum amount of stress. Investigators need to consider the time of day, time of year (moult or breeding status of the birds), weather, number of birds to be captured, number and training of staff required, and the possibility of predation. They must be familiar with the biology and behaviour of the species they are capturing, and plan all captures and releases accordingly. For example, some species are flightless during moult and should be captured and released in a way that does not affect their survival during this vulnerable stage. Breeding birds (e.g., incubating females) must be released as soon as possible to avoid prolonged absence from the nest (<1 hour, depending on the species). Diurnal birds should never be released after nightfall as they may have difficulty finding a suitable roost for the night and be vulnerable to nocturnal predation.

In general, when deciding on a capture method, the following should be considered:

- mesh size of net or trap should be appropriate to the species targeted so that birds are not able to escape, become entangled or injured;
- traps should be have no sharp edges that might injure birds or investigators;
- the opening of a trap should be positioned to allow the investigator to reach all parts of it to remove birds easily;
- for units with trap doors or moving parts, all mechanisms should be in good working order and be safe for trapped birds and investigators;
- techniques should avoid disturbance to vegetation, as flattening of vegetation may affect concealment and result in increased predation; and
- non-target species may be captured, and procedures to deal with them should be predetermined and followed should this occur.

Bird capture should be reassessed if the combined injury/mortality rate exceeds 0.5% (1 in 200); however, with some techniques (e.g., cannon nets), the casualty rate may be higher (i.e. 2-3%). Before trapping begins, investigators must have management plans in place for birds injured or killed during capture. The plan should include information on endpoints (i.e. identification of the person(s) responsible for monitoring and applying endpoints, and signs and symptoms to be used when evaluating the animal, how endpoints will be applied, and the method of carcass disposal). The *CCAC guidelines on: laboratory animal procedures –adopted guidelines on euthanasia* (in prep.) and the *CCAC guidelines on: the care and use of wildlife* should be consulted for information on euthanasia (www.ccac.ca/en/CCAC_Programs/Guidelines_Policies/GDLINES/Guidelis.htm). If avian rehabilitation facilities are available in the area, they should be contacted in advance of the trapping, and the criteria for the transfer of birds to these facilities should be established. All serious injuries and mortalities, and the circumstances surrounding them, must be recorded. If deaths occur, subsequent use or disposal of carcasses must also be recorded. It should not be assumed that there is not underlying illness, even in seemingly straightforward capture mortalities. Sick birds may be more likely to injure themselves when captured, although they may seem outwardly healthy (it is common for prey species to mask illness when captured). Knowing the cause of death can help refine capture protocols and alert handlers to the presence of zoonotic diseases. Capture mortalities should be submitted for examination (at no cost) at the appropriate regional branch of the Canadian Cooperative Health Centre (CCWHC, www.wildlife1.usask.ca/en/local_submission_forms.php).

Additional Resources:

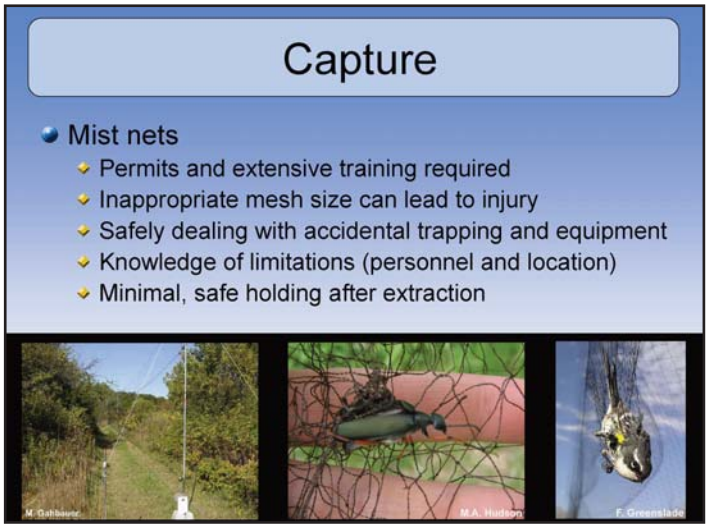
Bloom P.H, Clark W.S. & Kidd J.W. (2007). Captive breeding for research and release. In: *Raptor Research and Management Techniques*. (eds. D.M. Bird & K.L. Bildstein) Surrey BC: Hancock House Publishers, Ltd.

Bub H. (1995) *Bird Trapping and Bird Banding: A Handbook for Trapping Methods All Over the World*. New York NY: Cornell University Press.

Day G.I. Schemnitz S.D. & Taber R.C. (1980) Capturing and marking wild animals. In: *Wildlife Management Techniques Manual* (ed. S.D. Schemnitz.), pp. 61-88. Washington DC: The Wildlife Society.

Taber R.D. & Cowan I.M. (1969). Capturing and marking wild animals. In: *Wildlife Management Techniques*, 3rd ed. (ed. R.H. Giles), pp. 277-317. Washington DC: The Wildlife Society.

SLIDE 15



Mist nets may be used for capture of passerines, raptors, waterbirds and shorebirds. The use of mist nets requires a federal permit.

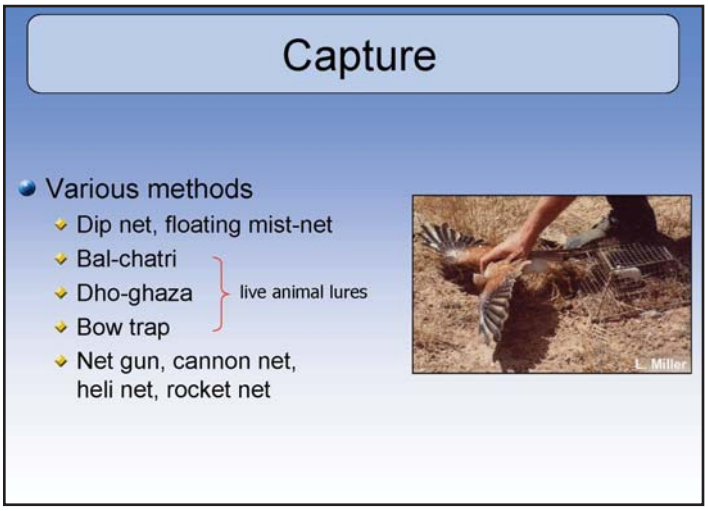
When using mist nets the following should be noted:

- Rigorous training is required; extracting birds from mist nets is a skill that must be developed. Mist nests have the potential to capture a large number of birds in a short amount of time. Nets that are not set properly, not monitored sufficiently or not monitored by skilled extractors, have the potential to injure and kill birds. Occasionally, a bird may become highly tangled, requiring an experienced extractor who knows how to handle these occurrences.
- The appropriate mesh size for the targeted species or species group should always be used. Inappropriate mesh size can lead to injury and reduced trapping efficiency.
- Experience is important when determining which birds to extract from the net first, and how to deal with accidental trapping (dragonflies, insects, bees, bats, etc.) and the potential for rabies, which is why extraction training is critical when using mist nets. Additional information on extraction is available at www.migrationresearch.org/mbo/extraction.html and www.fs.fed.us/psw/topics/wildlife/birdmon/landbird/body_grasp.pdf.
- Birds should be safely extracted from nets and placed in safe holding devices (e.g., pens for shorebirds, and cotton or paper bags for passerines) as soon as possible.
- If there are more birds captured than can be removed within 20-30 minutes, the net should be closed. If birds will be held for more than one hour, some birds should be released at the net to shorten the processing time for those retained.
- Mist nets should be closed during precipitation or high winds, and during the night unless attempting to capture nocturnal species or shorebirds. If nets are left open during the night, they should be checked as frequently as during the day, and suitable headlamps should be worn to extract birds from the net.
- When not in use, mist nets should be taken down or closed and securely tied.

Additional references:

Keyes B. & Grue C. (1982) Capturing birds with mist nets: A review. *North American Bird Bander* 7(1): 2-14.

SLIDE 16



The following are further examples of capture methods. Investigators should ensure the appropriate capture method is employed for their species of study.

Dip nets, submerged mist nets, and floating gill nets are used to capture birds in the water. The use of dip nets involves closely approaching the birds by boat, extending the net under the water and quickly raising the net once the bird is positioned centrally over it. Dip nets may be effective for capturing incubating waterfowl on nests, particularly during the last stages of incubation (e.g., < 1 week prior to egg hatching). **Floating mist-nets** are regularly used to capture migratory waterfowl and occasionally passerines in submerged habitat.

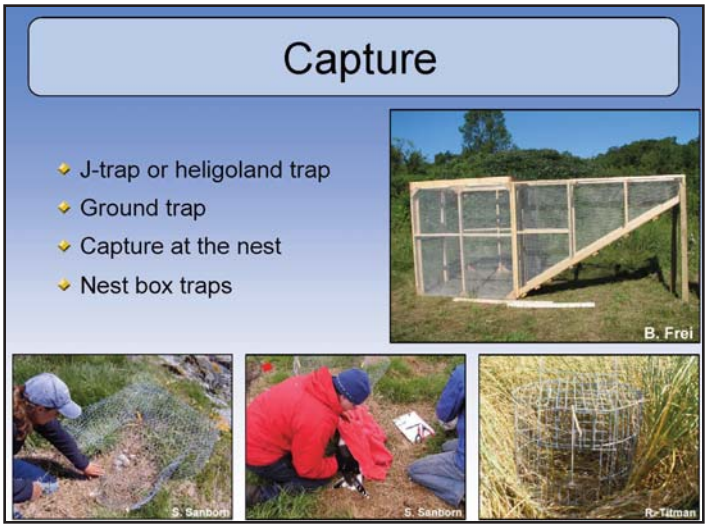
Bal-chatri and **dho-ghaza** traps use live bait (usually rodents or small birds) as lures for raptors. These traps must be constantly monitored as the bal-chatri leg nooses have the potential to injure birds struggling to escape, and the time during which the lure animal is exposed to its predator should be minimized. Investigators must ensure that lure animals are protected from injury, and provided with food and water. Some investigators are now using either static or remote controlled moving specimens, rather than live lure animals.

Bow traps are typically used for ground-nesting birds; however, they may be used throughout the year on a variety of species. A metal arch supporting a net springs up over the bird. The mechanism should be triggered by the investigator rather than by the bird itself, and the trap should be watched continuously. The bird must be removed immediately to avoid injury. When used over a nest, eggs should be replaced with dummy eggs and kept warm by the investigator until being replaced in the nest after trapping is completed.

Net guns are used for capturing individual birds, and cannon and rocket nets are mainly used for flocks and shorebirds. These should be operated only by highly trained and experienced personnel to avoid injury to birds or field personnel. **Cannon** and **rocket nets** use projectiles that are propelled by the explosion of a charge. These explosive charges can be made by trained personnel using commercially available firing caps and ammunition powder, following the manufacturer's instructions. The use of projectiles must be authorized on banding permits, and must be conducted only by trained people with experience.

Heli net scooping of swans and geese during moult should follow the general rules for net gunning. Herding flightless waterfowl into corral traps by helicopter or other means should be conducted slowly and with an adequate number of personnel to reduce stress and prevent birds from escaping into unsafe areas. Whenever possible, birds should be herded by personnel on the ground rather than by helicopter. This reduces the stress on the birds and minimizes the risk of non-moulting (i.e. still capable of flight) birds flying into the blades of the helicopter while trying to escape.

SLIDE 17



Bait traps, including J-traps, ground traps and large decoy enclosures, are used to capture ground-feeding, seed-eating birds and ducks. Birds can remain in these traps for several hours if they are not subject to injury from other birds or themselves, and if conditions are appropriate (i.e. sufficient food and water, favourable weather, appropriate tidal conditions, and absence of predators). However, frequent checks should be made to ensure that these conditions are always met and that local breeders are not kept away from the nest for prolonged periods of time.

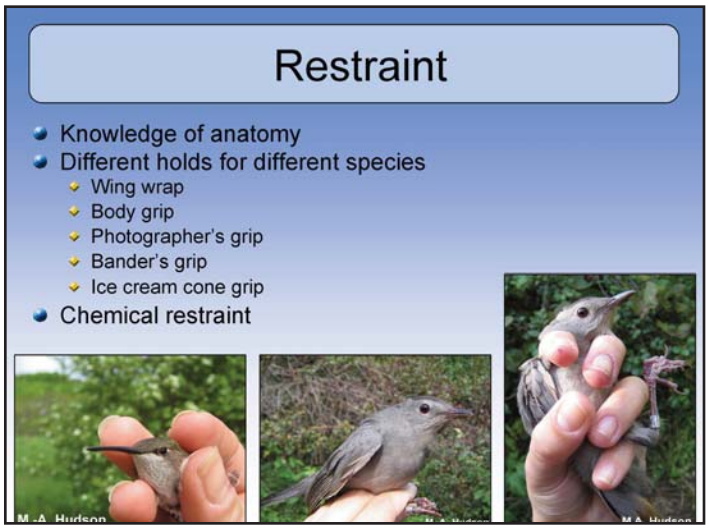
Heligoland or **J-traps** are generally permanent structures. Since the birds do not enter the holding box unless someone drives them in, these traps do not have to be closely monitored providing the cage door is kept open (i.e. the trap is not set). When the cage door is closed, checks should be made every 30 minutes, driving birds into the holding box and immediately removing them.

When selecting a method to capture birds at nests, investigators should ensure minimal disturbance to the birds, their eggs, and the vegetation around the nest to avoid attracting predators. For endangered species, the importance of minimizing disturbance is critical as the stakes for them are very high. It is also important that the biology of the species is known to ensure there is minimal risk of nest desertion. Where little is known about the species, a pilot study should be conducted first.

Mist nets, hand nets, nest traps and noose nets are all commonly used methods for trapping birds on or near nests. These traps should be monitored at least every 20 minutes under good conditions, and birds should be removed, processed and released as soon as practical. Nest traps should not be reset on the same nests immediately following an unsuccessful capture since this may result in the eggs being improperly incubated and increase the risk of nest abandonment.

Birds nesting in cavities can usually be captured in nest boxes. **Nest box traps** contain a mechanism that is triggered to shut the box when the bird enters. Alternatively, the investigator can capture a bird in the box by blocking the box entrance and sliding the other hand through the door to quickly catch the bird inside. All birds trapped on nests, regardless of type of trap, must be captured as close as possible to egg hatching to minimize desertion of the nest by the female.

SLIDE 18



Training in restraint from an experienced handler is required to ensure that field personnel are confident and capable in appropriate methods of handling birds. Because birds must move their whole keel during respiration, a grip that is too tight may cause the bird to suffocate.

Field personnel should be familiar with several grips (i.e. wing wrap, body grip, photographer's grip, bander's grip and ice cream cone grip) and their suitability to different species of birds to ensure the safety of both the bird and the handler. When handling birds with short legs (e.g., Swallow species, Belted Kingfisher, etc.), the bander's grip is preferable. Hummingbirds should be held in a body grip. Larger species may need to be restrained with gloves, towels and blankets, and where such protective measures are used, it is critical that the handler is properly trained so that the bird is not suffocated and the handler is adequately protected.

If chemical restraint is to be used, this must done under the supervision of a licensed veterinarian, as chemical side effects may include hypothermia and other physiological changes which may or may not be known or anticipated. Excitatory stimulation, physiological depression and other adverse reactions to a drug may exacerbate stress in the bird. A more in-depth look at general and topical anaesthetics and analgesics is included in this module.

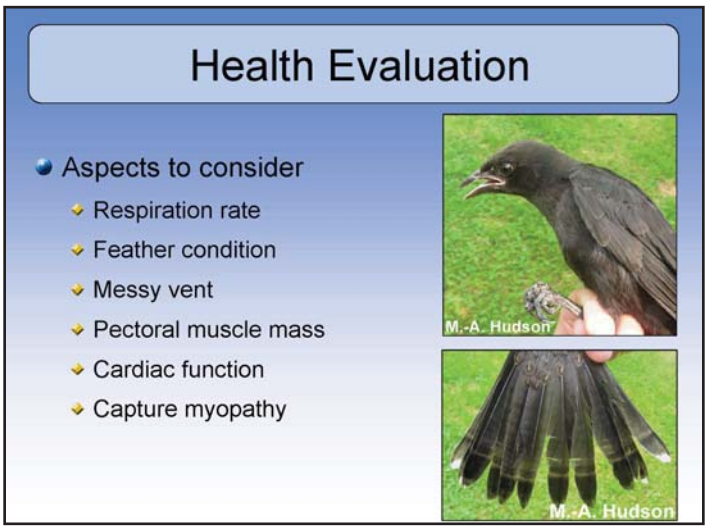
Investigators performing wildlife anaesthesia and immobilization are encouraged to take courses offered by the Canadian Association of Zoo and Wildlife Veterinarians at www.cazwv.org/workshops.htm

Additional references:

North American Banding Council (2001) *North American Bird Banding Manual*, vol. 1. Available at: www.pwrc.usgs.gov/BBL/manual/manual.htm.

Ralph C.J. (2005) The body grasp technique: a rapid method of removing birds from mist nets. *North American Bird Bander* 30: 65-70. Available at: www.fs.fed.us/psw/topics/wildlife/birdmon/landbird/body_grasp.pdf

SLIDE 19



Once the bird is restrained, it is necessary to know if it is healthy before marking or conducting any other procedures. Bird care and condition is a consideration not only from an ethical point of view, but also from a research perspective: a compromised animal will not make a good study animal.

During a health evaluation, the investigator should consider the following aspects:

- **Respiration rate**: open-mouthed breathing is not always linked to the stress of capture and handling, but should be considered. If prolonged or noisy, this can indicate disease.
- **Feather condition**: feathers should be intact, relatively parasite-free and waterproof.
- **Messy vent**: staining or clumping of vent feathers with droppings may be caused by diarrhoea or other illness, or may be due to injury and inability to void properly.
- **Pectoral muscle mass**: loss of pectoral muscle mass indicates emaciation which can indicate disease, injury or lack of fitness.
- **Cardiac function**: tachycardia (rapid heart beat) or bradycardia (slow heart beat) may indicate underlying disease or toxic state. Although extremely difficult to evaluate in small birds (some passerines' heart rates are > than 400 bpm), it still may be valuable to assess in larger species.
- **Capture myopathy**: stress during capture can result in capture myopathy, which can be indicated by muscle tremors and a catatonic state. This can be reduced by effective trapping, reduced handling time, low light conditions, and ensuring ambient temperature does not exacerbate hyperthermia induced during capture. A hood or blindfold made of breathable materials, using a cover, or working in a box, depending on the species, may also minimize stress. If myopathy occurs, the bird will enter into a catatonic state. This may be remedied by keeping the bird in a quiet, warm environment. A veterinarian or licensed bird rehabilitation centre should be consulted. Severe capture myopathy is grounds for euthanasia and review of restraint techniques and times.

SLIDE 20

Capture and banding of migratory birds requires a scientific permit issued by the Bird Banding Office (BBO) of the Canadian Wildlife Service. The BBO also tracks encounters and recoveries banded in Canada, and provides banding and recovery information upon request. In addition to application forms and testimonials, applicants must provide the BBO with a project description detailing capture and marking protocols and demonstrate that they have adequate training, knowledge and experience with capture, handling, identification, ageing, sexing and marking for species with which they propose to work. Application forms and more information are available online atwww.cws-scf.ec.gc.ca/nwrc-cnrf/default.asp?lang=En&n=B197CA34-0.

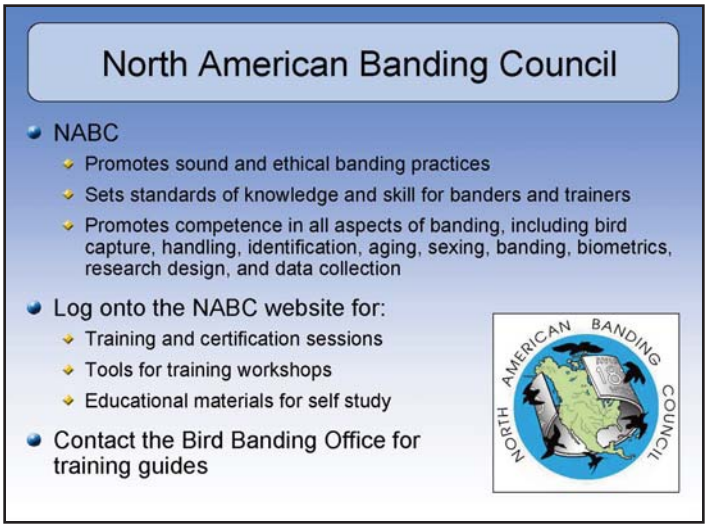
All field personnel banding birds should be familiar with the appropriate North American Banding Council (NABC) guides. Those with extensive experience capturing, handling, banding, ageing and sexing birds may apply for a permit for specific groups of birds, or investigators may apply for species-specific permits.

To ensure the safety and welfare of birds and maintain a high standard for collected and shared banding data, field training is required before a banding permit will be issued. Anyone applying for a banding permit must have demonstrated competence with the following:

- capture and extraction;
- handling birds using a variety of grips;
- safely opening the mouth of a bird;
- correcting an improperly applied band;
- removing a band safely;
- identifying target species;
- determining the age and sex of species of interest using a variety of methods and appropriate ageing and sexing guides;
- taking accurate morphometric measurements and recording data clearly and accurately;
- understanding the ethics of banding and how banding fits into scientific studies; and
- knowing their own limits, including when to close nets and release unbanded birds if more birds are captured than can safely be processed in a reasonable amount of time.

The correct band size must be used or serious injury may result. Recommended band sizes for all species of North American birds can be found in the *Bird Banding Manual* (www.pwrc.usgs.gov/BBL/manual/manual.htm) and in periodic *Memoranda to Banders* issued by the Bird Banding Office. However, individual variation may require that field personnel use a leg gauge to ensure that an appropriately sized band is used. Also, investigators in marine environments may wish to use stainless steel as opposed to aluminum bands.

SLIDE 21



The North American Banding Council (NABC) (www.nabanding.net/nabanding/), incorporated in 1998, is a non-profit group encompassing bird research organizations whose members use bird banding as a tool in ornithological research, conservation and management. The mission of the NABC is to promote sound and ethical bird banding practices and techniques. To accomplish this, the NABC has developed educational and training materials for bird banders, including training guides on general banding techniques, as well as techniques guides for specialized taxonomic groups including passerines and near-passerines, raptors, hummingbirds, shorebirds, and waterfowl (www.nabanding.net). All field personnel banding birds should be familiar with the appropriate NABC guides.

The NABC manages a voluntary bander certification program. Certification requires passing a written test and field evaluation of banding skills. Certification is available at three levels: assistant bander, bander and trainer.

The *Bander's Code of Ethics* is available online at www.nabanding.net/nabanding/ethics.html. Manuals are available free of charge through the Bird Banding Office (www.nabanding.net/nabanding/pubs.html), which can provide further information and access to other training materials.

Additional Resources:

Gratto-Trevor C.L. (2004) *The North American Bander's Manual for Banding Shorebirds*. North American Banding Council.

Harper R.G. & Neill A.J. (1990) Banding technique for small nestling passerines. *Journal of Field Ornithology* 61:212-213.

McCracken J.L., Enright D., Sheppard E.D., Cappelman J. & Dunn E. (1999) *The Canadian Bird Bander's Training Manual*. Canadian Wildlife Service, Environmental Conservation Services, Technical Report Series No. 275. 114 pp. National Wildlife Research Centre.

North American Banding Council (2001) *The North American Banders' Manual for Banding Passerines and Near Passerines*. North American Banding Council.

North American Banding Council (2001) *The North American Banders' Study Guide*. North American Banding Council.

North American Banding Council (2001) *North American Bird Banding Manual*, vol 1. Available at: www.pwrc.usgs.gov/BBL/manual/manual.htm.

SLIDE 22

Marking is crucial for identifying individuals within a study protocol. This can be achieved in a number of ways, such as banding, micro-chipping, patagial tagging, colour-marking, etc. Each of these methods has its own considerations and longevity, which must be addressed in each protocol. Pilot studies are particularly important when marking techniques are being used for the first time on a species. Capture and marking of migratory birds requires a scientific permit issued by the Bird Banding Office of the Canadian Wildlife Service. Some markers may require regional, national or international coordination.

Marking methods must be selected according to the biology of the species, and the purpose and time span of the study.

In choosing an acceptable marking technique, the investigator must ensure that:

- the nature and duration of restraint is appropriate;
- a short amount of time is taken to mark the bird;
- the marker will not impede movement, hinder and/or irritate the bird (e.g., markers attached to diving birds will not increase chances of the bird being caught on submergent vegetation);
- the marker will not compromise the bird's camouflage;
- the marker allows for seasonal changes and growth in juveniles;
- the marker does not impact reproductive success, social interactions, longevity, migration or vulnerability to predation;
- moult chronology is considered;

- the marking code (digits or colours) is readily visible and distinguishable, and persists until research objectives have been fulfilled;
- pain is minimized;
- the amount of tissue removed or damaged (if any) is negligible;
- the risk of infection is minimized;
- accurate records of the marking procedure are kept; and
- they are prepared to respond to concerns from the public in an informed and helpful manner.

Investigators should be aware of problems and new developments associated with the type of marking used, and are encouraged to publish results of studies showing the effectiveness of the marker type or design, including any negative impacts, so that this can be taken into account by other investigators.

SLIDE 23

In addition to the uniquely coded metal leg bands issued by the Bird Banding Office, auxiliary markers may be used for individual or cohort identification in the field without recapture. The use of such markers requires authorization on the banding permit. Certain colours, especially those similar to plumage or soft parts involved in social signalling, may affect mating attractiveness, dominance status, or aggression in some species, so knowledge of the study species is critical. Also, depending upon the duration of the study, it may be important to consider that some colours fade and may become unrecognizable. Ultra-violet (UV)-stable bands are available from several suppliers.

Examples of auxiliary markers include: lacquers, commercial hair bleaches, colouring dyes, coloured tape tags, patagial tags, plastic collars, nasal discs, web tags, nape tags, telemetry, etc. All material must be non-toxic as the bird may ingest it while preening. Dyes applied to birds' plumage are commonly used on colonial waterbirds and waders. Waterproof, felt-tip markers are useful for short-term markers, as are tattoo inks, wax cattle-marking sticks, and non-lead paint. Picric Acid, Rhodamine B and Malachite Green are also frequently used. Picric acid, however, can be a significant explosion hazard and its use is strongly discouraged.

Investigators must be very careful when applying dye, especially when contour feathers are extensively coloured. The colorant may act as a wetting agent, leading to loss of wa-

terproofing. It is important to ensure that dyed birds are thoroughly dry prior to release. Dyed birds may be treated differently by conspecifics, and may experience an increased predation risk. These risks should be evaluated as they may influence not only the welfare of the subjects, but also the research results.

Mass-marking of birds in roosting or nesting colonies using aerial and ground spraying with fluorescent markers has been done. However, recent evidence indicates that some birds have the capacity for UV vision, and may use fluorescent plumage for mate selection. Until this is further defined, mass marking of birds with fluorescent markers is not recommended. In addition, as with any spray application, the composition of the spray formulation should be examined for potential environmental concerns.

Plastic neck bands or collars, mainly used for marking geese species, are effective, although some negative effects have been documented. Nasal discs or saddles (numbered and/or coloured plastic discs or plates applied to each side of the bird's bill and fastened together through the nasal opening) are used for tagging waterfowl. Responses differ among species (diving versus dabbling, etc.), and investigators should systematically evaluate any possible negative effects.

Additional Resources:

Arnold K.E., Owens I.P.F. & Marshall N.J. (2002) Fluorescent signaling in parrots. *Science* 295:92.

Calvo B. & Furness R.W. (1992) A review of the use and effects of marks and devices on birds. *Ringing and Migration* 13:129-151.

Hausmann F., Arnorld K.E., Marshall N.J. & Owens I.P.F. (2003) Ultraviolet signals in birds are special. *Proceedings of the Royal Society B* 270: 61-67.

Kennard J.H. (1961) Dyes for color marking. *Bird-Banding* 32:228-229.

Marion W.R. & Shamis J.D. (1977) An annotated bibliography of bird marking techniques. *Bird-Banding* 48:42-61.

Neitfeld M.Y., Barrett M. & Silvy N. (1996) Wildlife marking techniques. In: *Research and Management Techniques for Wildlife and Habitats* (ed. T.A. Bookhout), pp. 140-168. Bethesda MD: The Wildlife Society.

Paton P.W. & Pank L. (1986) A technique to mark incubating birds. *Journal of Field Ornithology* 57:232-233.

Sherwin C.M. & Devereux C.L. (1999) Preliminary investigations of ultraviolet-induced markings on domestic turkey chicks and a possible role in injurious pecking. *British Poultry Science* 40:429–433.

SLIDE 24

During the past three decades, the attachment of small transmitters to free-living birds has become a routine way of monitoring the location and movements of tagged individuals. Radio and satellite telemetry is becoming increasingly popular for remotely monitoring avian physiology, behaviour, habitat use, survival and movement.

Transmitters should be as small as possible and must not exceed 5% (including the weight of the battery and any other tracking material being used) of the pre-feeding/fasted body mass of the animal. It is important not to overestimate the bird's weight due to recent feeding, as birds can consume a large portion of their body weight at a time.

Transmitters can be glued to the back of the bird, placed on the back with a harness over the legs, attached to a metal leg band, prong-and-sutured into the back (involves a small incision to attach a transmitter), implanted into the back (involves a subcutaneous or abdominal incision), glued onto tail feathers, or attached to neck bands. Investigators must search the relevant literature to ensure that the method they propose is the most appropriate and can be safely applied to their study species.

Radio transmitters can have significant adverse effects on survival, reproductive success, energetics and behaviour, so the use of transmitters should be undertaken with caution and only when the data cannot be obtained in any other way. Depending on existing information, it may be necessary to conduct a pilot study to test for behavioural effects. Assuming a transmitter of appropriate size is used, most negative effects are usually limited to the attachment method. Investigators should try to use external transmitters that break away within a pre-planned time period (e.g., with moult) or when remotely triggered by using biodegradable ties or specially-designed attachments that quickly and completely "self-remove".

Surgical interventions, including laparotomies, radio transmitter implants and other invasive procedures that expose the abdominal cavity or other deep tissues, should be done only by a veterinarian or under a veterinarian's close supervision. These should be planned in advance, with sterile techniques and emergency procedures in place.

In order to use radio transmitters, a permit or license may be required from Industry Canada, depending on the frequency used. Industry Canada should be consulted for frequency allocations, legislation and permitting issues (www.ic.gc.ca).

A newer telemetry system, referred to as harmonic radar and/or PIT tags, uses a microwave pulse detector on a tag that emits a VHF signal only when it detects a specific mi-

crowave pulse from a radar transmitter. These tags, each containing an individual digital code, are injected under the skin or glued to the back. The code is detected by a scanner that is passed over the bird's body. They offer the advantage that, if the tagged bird can be induced to enter the field of a scanner (e.g., at feeding or nesting sites), various data can be automatically recorded and assigned to specific individuals, thus eliminating the need for additional handling.

Additional references:

Amlaner C.J.Jr. & MacDonald D.W. (eds.) (1980) *A Handbook of Biotelemetry and Radio Tracking*. Oxford: Pergamon Press.

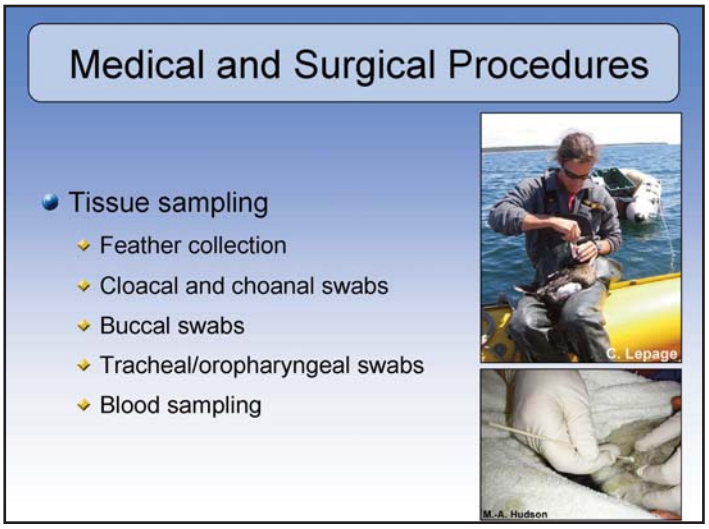
Cochran W.W. (1980) Wildlife telemetry. In: *Wildlife Management Techniques*, 4th ed. (ed. S.D. Schemnitz) pp. 507-520. Washington DC: The Wildlife Society.

Dougill S.J., Johnson L., Banks P.C., Goltz D.M., Wiley M.R. & Semones J.D. (2000) Consequences of antenna design in telemetry studies of small passerines. *Journal of Field Ornithology* 71(3):385-388.

Karl B.J. & Clout M.N. (1985) An improved radio transmitter harness for birds, with a weak link to prevent snagging. *Journal of Field Ornithology* 58:73-77.

Kenward R.E. (1987) *Wildlife Radio Tagging*. London: Academic Press.

SLIDE 25



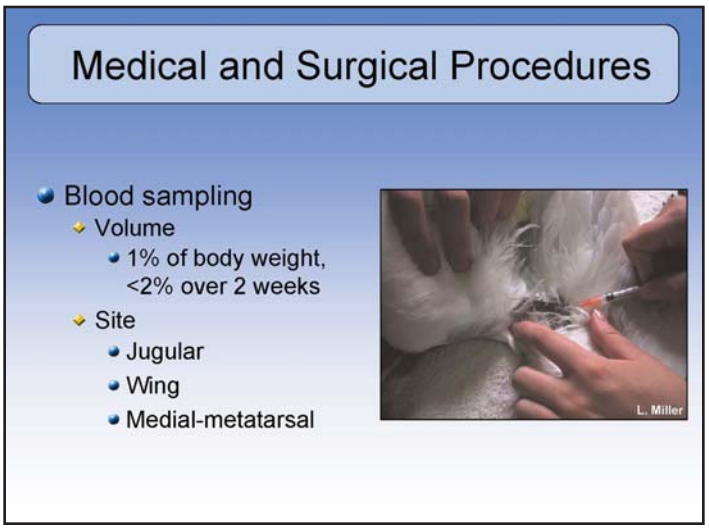
Federal, and in some cases provincial or territorial, scientific collection permits are required when collecting tissue samples for research. However, swabs can be authorized on banding permits.

For any invasive tissue collection (e.g., biopsy), the protocol must employ measures to ensure pain is managed at the time of sampling and for a period after the procedure.

Collecting feather pulp samples is a relatively innocuous technique; however, pulling major flight feathers may require anaesthesia or analgesia.

Collecting swabs is a minimally invasive procedure, and samples may be collected from the cloacal, choanal, buccal, and oropharyngeal regions, resulting in very little discomfort to the bird. Cloacal swabs are collected by opening the cloaca and gently swabbing the inner surfaces. Choanal swabs are collected from the slit in the palette in the roof of the mouth. Buccal swabs are collected from inside the cheek and over the tongue. Tracheal/oropharyngeal swabs are collected from the mucosa in the tracheal region.

SLIDE 26



The best site for blood sampling depends on the species. Knowing the species and the impact sampling may have on the individual is crucial. The blood volume of birds ranges from 5 to 20 ml per 100 g. In most birds, up to 1% of body weight (e.g., 1.0 ml per 100 g bird) can be collected with few negative effects, and no more than 2% over a two-week period.

As with all procedures, all necessary equipment should be assembled and organized prior to handling the first bird. Investigators must ensure they have appropriately sized sterile blood-collecting equipment (e.g., correct gauge of needles) and containers for disposal of sharp and contaminated materials. The type of container the blood is collected in depends on the protocol (i.e. what is the sample being collected for?). It is critical that the appropriate container be used, or the samples may go to waste. The investigator should also be aware of any idiosyncratic reactions of the samples. For example, corvid blood will hemolyze in CaEDTA, so heparin should be used if whole blood is needed. The bird must be comfortably and safely restrained. A light towel or loose-fitting hood can be placed over the head of the bird to reduce visual stimulation and reduce stress. The venipuncture site should be prepared by gently swabbing with an **extremely small amount of alcohol** (excessive amounts may result in the vein shutting down). Use of soaps or disinfectants (e.g., chlorhexidine) is discouraged due to the potential loss of waterproofing in the feathers.

There are several collection sites that can be used, depending on size and species. The jugular vein is a useful site for a venipuncture, since there is often a featherless area of skin overlying this vessel and the vein can clearly be seen through the skin. It is imperative that bleeding is stopped immediately after sample collection to avoid haematoma formation (leakage of blood from the vein into surrounding tissues). Blood lost into a haematoma is also lost to the circulatory system, and it is possible for a small bird to die from losing too much blood this way. Applying gentle digital pressure (10-30 seconds) is essential to control the formation of haematomas. Holding the bird in an upright position (with its head higher than its heart) also aids in haemostasis.

The brachial or wing vein and medial-metatarsal vein are also useful venipuncture sites. For haemostasis, digital pressure is applied over the site of the needle puncture, taking care not to break the fragile bones (e.g., for small birds, the limb is pinched between thumb and forefinger over the site of the needle puncture). Blood stop powder (iron sulphate powder) or tissue glue may be used if absolutely necessary.

Collection of blood by nail-clipping should be avoided since it is painful and can be associated with significant haemorrhages. It is therefore not an acceptable technique in modern avian medicine.

Additional references:

Dorrestein G.M., Blaauboer B.J., Miltenburg N.A. & Deley P.P. (1978) A modified method of blood sampling from birds. *Lab Animal* 12:193-194.

Hoysak D.J. & Weatherhead P.J. (1991) Sampling blood from birds - a technique and an assessment of its effect. *Condor* 93: 746–752.

SLIDE 27

The use of neck ligatures on nestlings and emetics (chemicals that induce vomiting) for collecting food samples should be used only if no other methods of obtaining information on diet in the field are available. Ligatures should not interfere with normal blood circulation or tracheal function, nor result in unintentional food deprivation.

Emetics are dangerous and can cause death if not properly administered. Small doses of some emetics (e.g., potassium antimony tartrate) can be toxic because they will not induce vomiting. An overdose is less dangerous than under dosing because it will cause vomiting and loss of the emetic. The risk of mortality from the use of emetics may be reduced by ensuring the appropriate amount of emetic is administered for the target species. Current research suggests that a technique using the over-the-counter drug ipecac (ipecacuanha) is considered a preferable non-toxic alternative. Where information is lacking, pilot studies should be conducted to determine the appropriate dose by examining the effects of the emetic on the target species under the conditions of the study (e.g., time of day, time of year, etc.). Adequate time to access certain veterinary drugs should be allowed, as some of these may require weeks or months to obtain via an Emergency Drug Release from the Veterinary Drug Directorate.

Laparotomies are used to determine the stage of gonadal development or to determine the sex of some bird species when other means fail. A less invasive technique for sexing birds, which should be used if possible since it can also extract isotope information, involves using DNA extracted from a tissue or blood sample. Feathers can also be used to obtain DNA, often with less risk to the bird and less logistical problems. However, if accurate sex determination is a priority for the protocol (e.g., in capture breeding and release programs), then a laparotomy is preferable. Laparotomies should be undertaken only by experienced personnel under the supervision of a veterinarian, and require general anaesthesia. When a small puncture is made for a laparoscope, it may not be necessary to seal the wound with methods including tissue glue. However, it is prudent to close all wounds to reduce post-operative complications.

Additional references:

Carlisle J.D. & Holberton R.L. (2006) Relative efficiency of fecal versus regurgitated samples for assessing diet and the deleterious effects of a tartar emetic on migratory birds. *Journal of Field Ornithology* 77: 126–135.

Diamond A.W., Fayad V.C. & McKinley P.S. (In press) An improved emetic for wild birds: Ipecac. *Journal of Field Ornithology*. Accepted 11 July 2007.

Fridolfsson A.-K. & Ellegren H. (1999) A simple and universal method for molecular sexing of non-ratite birds. *Journal of Avian Biology* 30:116-221.

SLIDE 28

Investigators must consider, in consultation with a veterinarian, which anaesthesia and/or analgesia methods (e.g., local or general) are appropriate for the study objectives and study species. Research protocols involving invasive procedures must address the issues of anaesthetic technique, the possibility of pain and its management, and the long-term impact sampling may have on the individual.

Anaesthesia, the induction of a loss of sensation either locally or generally (unconsciousness), may be induced by several means and must be thoroughly explained in the research protocol. In wildlife studies, most drugs will be used 'off label' (any pharmaceutical that is used in a species that the company has not sought approval for is considered to be used 'off-label') and species tolerances and differences in reaction may not be widely understood. Local anaesthetics are fast-acting but not very useful for birds, unless used with extreme caution. Overdosing is a potential problem, with possible toxicity if given intravenously. Topical anaesthetics can destroy waterproofing and damage feathers, and there is the potential for toxicity if preened or licked. General anaesthesia with inhaled or injected anaesthetic agents induces unconsciousness in birds.

Analgesia, a temporary relief of pain without unconsciousness, should be used in conjunction with, or following, anaesthesia if a procedure inflicts post-operative pain.

Further information is available at: www.iwrc-online.org and www.cvmbs.colostate.edu/ivapm. The International Wildlife Rehabilitation Council (IWRC) offers an on-line training course on pain in wildlife, and the International Veterinary Academy of Pain Management offers annual meetings and information relating to pain in animals. Anyone performing wildlife anaesthesia and immobilization is encouraged to take a course offered by the Canadian Association of Zoo and Wildlife Veterinarians (www.cazwv.org/workshops.htm).

Additional references:

Abou-Madi N. (2001) Avian Anesthesia. *Veterinary Clinics of North America; Exotic Animal Practice* 4(1):147-167.

Elzanowski A. & Abs M. (1991) Pain and stress in birds. In: *Acta XX Congressus Internationalis Ornithologici*. Christchurch, New Zealand, 1990. pp. 1901-1940. Wellington: Ornitholical Congress Trust Board.

Gentle M.J. (1992). Pain in birds. *Animal Welfare* 1:235-247.

Heard D.J. (1997) Anesthesia and analgesia. In: *Avian medicine and surgery* (eds. R.B. Altman, S.L. Clubb, G.M. Dorrestein & K. Quesenberry), pp. 807-827. Philadelphia: W. B. Saunders.

Lewis J. (2004) Field use of isoflurane and air anesthetic equipment in wildlife. *Journal of Zoo and Wildlife Medicine* 35:303-311.

Machin K.L. (2005) Avian pain: physiology and evaluation. *Compendium on Continuing Education for the Practicing Veterinarian* 27:98-109.

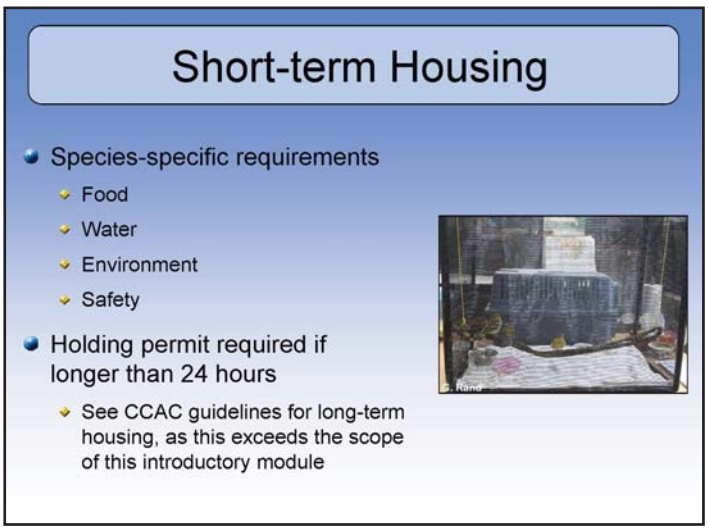
Machin K.L. (2005) Controlling avian pain. *Compendium on Continuing Education for the Practicing Veterinarian* 27:299-308.

Machin K.L. (2005) Avian analgesia. *Seminars in Avian and Exotic Pet Medicine* 14:236-242.

Machin K.L. (2004) Waterfowl anesthesia. *Seminars in Avian and Exotic Pet Medicine* 13:206-212.

Paul-Murphy J. & Ludders J. (2001) Avian analgesia. *Veterinary Clinics of North America; Exotic Animal Practice* 4(1):35-45.

SLIDE 29



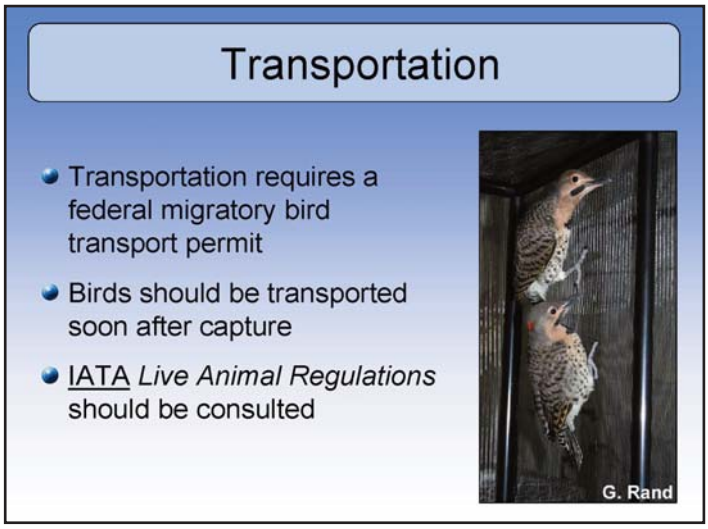
If holding is necessary to the protocol, investigators are responsible for ensuring all species-specific needs are addressed. Holding cages should be protected from direct sunlight, wind and precipitation, and be kept at a temperature appropriate for the species. Birds should also be held at a density appropriate for the species (see Chapter VI and Appendix I of the *CCAC Guide to the Care and Use of Experimental Animals*, volume 1). Conspecific housing is always preferable to having multiple species/ages in the same cage. All housing should be well ventilated, easy to clean, adequately lit, and safe for the bird in terms of eliminating risks of predation and disease transmission. Care should be taken to minimize psychological stress by shield-

ing cages from excessive light, noise, predators and human activities. Food must be appropriate for the species, and each bird should be observed eating. Aside from observation, weight checks and the presence of fecal matter are ways to monitor food intake. Clean water must be available at all times. Temperature and light must be maintained appropriately depending on the protocol and the study objectives.

For long-term housing, see Chapter VI and Appendix I of the *CCAC Guide to the Care and Use of Experimental Animals*, volume 1, as this topic exceeds the scope of this introductory module. There are many ethical and practical considerations associated with housing and husbandry standards, including behavioural enrichment, that must be considered.

There are resources available that are not strictly bird-related, but provide valuable information. The International Wildlife Rehabilitation Council (IWRC) (www.iwrc-online.org) preserves and protects wildlife through the support of wildlife rehabilitation, and the National Wildlife Rehabilitators Association (NWRA) (www.nwrawildlife.org/home.asp) is dedicated to improving and promoting the profession of wildlife rehabilitation and its contributions to preserving natural ecosystems. The IWRC/NWRA joint publication *Minimum Standards for Wildlife Rehabilitation* has a section on minimum cage requirements which is of particular use and should be consulted. This is available online at www.iwrc-online.org/pub/Standards%203rd%20Edition.pdf.

SLIDE 30



The transportation of migratory birds requires a federal migratory bird transport permit.

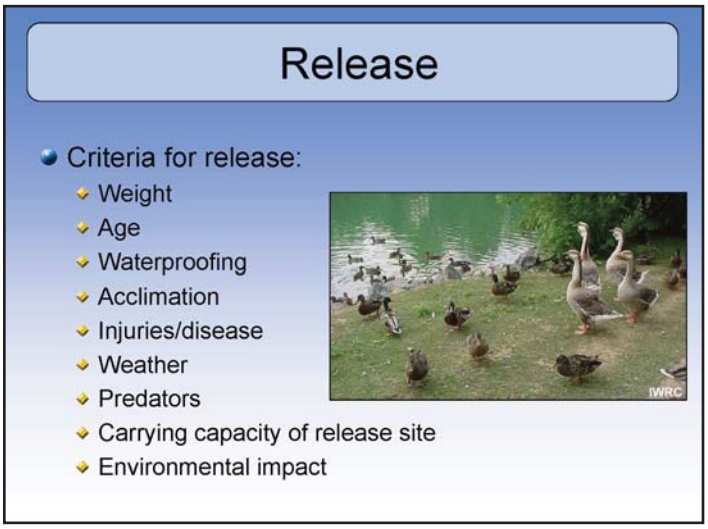
All birds should be shipped as soon as possible after capture. When possible, diurnal species should be transported at night and nocturnal species during the day to minimize activity. Birds should be isolated from humans and predators, kept away from windows and protected from direct sunlight. In general, they should be transported in separate cells; however, large or aggressive birds should always be transported in separate cells. Each bird should have sufficient space to assume normal postures and engage in comfort and maintenance activities. Space for flight is not recommended as birds may injure themselves.

The International Air Transport Association (IATA) *Live Animal Regulations* (http://www.iata.org/ps/publications/9105.htm) are a good source of information on con-

tainer designs for various bird species. Floors and inside tops of shipping containers should, depending upon the species, be padded. Perches should ordinarily be provided for longer duration transport, particularly for raptors. Perches should have non-slip surfaces and be appropriately sized. Shipping containers should be kept dark and adequately ventilated. Food and water, appropriate for the species needs, must be provided in spill-proof containers so that the bird's plumage will not become soiled.

For short trips (i.e. 10 minutes or less), birds of the same size and of non-aggressive species can be transported together; however, there is the risk of disease and/or parasite transmission. If it is necessary to carry birds over short distances to holding pens (e.g., a nearby barn with suitable enclosures), waterfowl can be transported in a covered truck that is adequately ventilated and lined with a thick layer of straw. While targeted at shipping of domestic farm animals, investigators are also referred to the Canadian Food Inspection Agency (CFIA) and National Farm Animal Care Council guidelines for humane transport (www.inspection.gc.ca/english/anima/heasan/transport/indexe.shtml and www.nfacc.ca/code.aspx).

SLIDE 31



Once a researcher has collected all required information from a bird, it should be released. However, release criteria must be laid out in the research protocol.

Examples of questions to be considered:

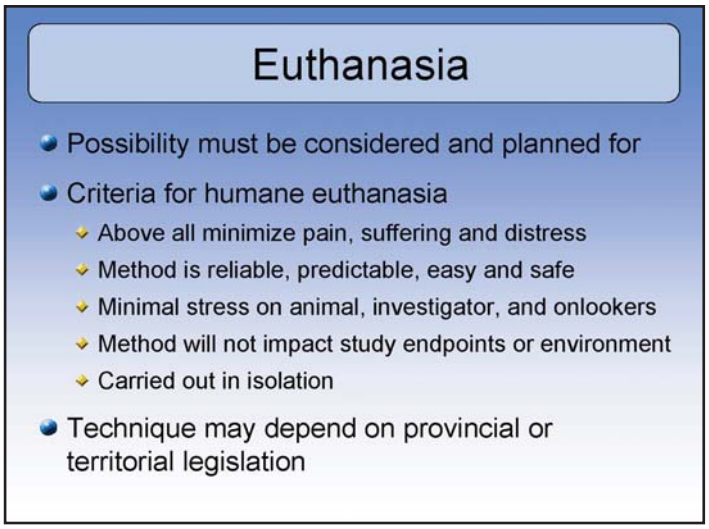
- Is this an appropriate bird for release or should it be rehabilitated or euthanized? This depends on whether the bird can survive on its own.
- Is the bird at an appropriate weight, is the pectoral muscle mass normal, and has its diet mirrored that of its species in the wild? Dietary changes with the annual cycle must be taken into consideration to ensure the optimal use of available nutrients and the body's ability to utilize them.
- For younger animals, is their release timed to mirror the period of independence from parental care and are they prepared for it?
- Are they waterproof? Any problems with housing or diet can be reflected in poor feathering and waterproofing loss.
- Do the birds require a period of acclimation or reconditioning to prepare them for release? Were the birds housed in such a way that natural day length patterns were not maintained?

- Have the birds sustained any injuries as a result of captivity? Could this result in poor survival? Is there any possibility of disease acquired in, or exacerbated by, captivity? A brief physical exam should be performed to ensure that the bird is apparently healthy and ready for release.

Other criteria to be evaluated:

- Weather considerations must play a role in the timing of release. Release should not occur if extreme weather patterns are forecast for several days.
- Release sites should be selected to minimize the risk of predation. Avoiding high populations of domestic cats and ensuring adequate cover from natural predators is strongly recommended.
- The carrying capacity of the site should be examined: is the site over-burdened with either wild or domestic species?
- Where possible, birds should be released near capture sites, particularly when dealing with nesting birds.
- Environmental impact of the release should be assessed, e.g., a predatory bird being released in an area where endangered species live.
- In game species, has the animal received any drugs that would make it unsuitable for human consumption?
- Release should not proceed any later in fall than the usual migration period so that survival ability is optimized. Otherwise, it may be a consideration to hold the bird in captivity over winter and release the following spring.
- Release of nocturnal species (particularly storm-petrels and small owls) should be scheduled for late evening at dusk to reduce the probability of predation and/or mobbing by other avian species.

SLIDE 32



The investigator must be prepared to euthanize any animal in the field that is suffering unrelievable pain and/or distress as a result of capture or handling procedures, or experimental intervention. The primary purpose of euthanasia is to terminate suffering, so speed is important. An animal that is already dying from severe trauma (e.g., from gunshot) should be terminated by the quickest available method compatible with preserving

the desired portions of the specimen. All information on endpoints, including appropriate methods of euthanasia and training of animal users, must be approved by the ACC.

Human psychological responses to euthanasia should be taken into consideration when selecting the method of euthanasia, but **should not** take precedence over animal welfare considerations.

The knowledge and skill of the person applying the method of euthanasia is critical in ensuring that an animal's death is humane. The safety of the operator should be given equal consideration. The technique adopted will be considerably influenced by the planned use of the body (i.e. as a museum specimen, for tissue chemistry or disposal). See *CCAC guidelines on: the care and use of wildlife* for information on euthanasia. Consultation with a veterinarian experienced in working with birds is useful in order to select the most appropriate method for use in the field.

Regardless of whether the procedure is applied to an individual bird or to a group, it must always attempt to meet the following criteria, adapted from *CCAC guidelines on: laboratory animal procedures – adopted guidance on euthanasia* and the Ornithological Council's *Guidelines to the Use of Wild Birds in Research* (www.nmnh.si.edu/BIRDNET/GuideToUse/Guidelines_2d_edition.pdf):

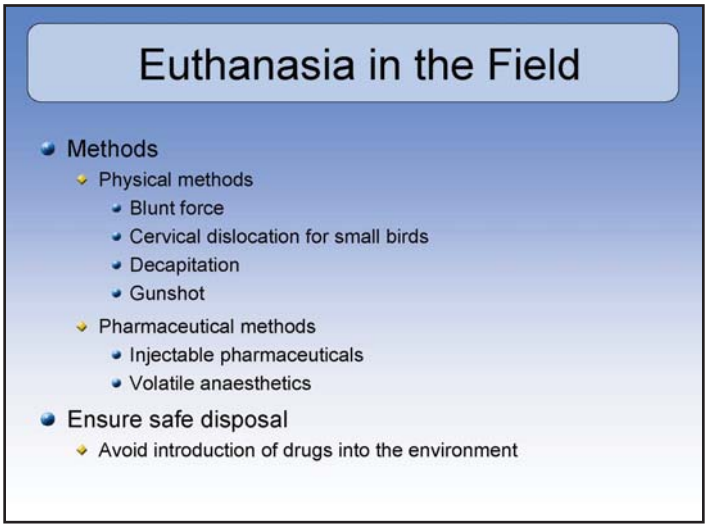
- death without signs of panic, pain or distress;
- rapid loss of consciousness, with interruption of consciousness and reflexes at the same time;
- compatible with requirements and the purpose of the study, i.e. no tissue changes that might affect post-mortem diagnosis;
- reliable, consistent, reproducible and predictable;
- easily and safely administered by properly trained personnel, and not subject to abuse by humans;
- uses simple equipment that is relatively maintenance free and available;
- minimal environmental or ecological impact;
- performed at a location away from other animals, as it is often difficult to recognize evidence of stress when animals are euthanized in the presence of other animals since they can communicate through various types of signals;
- safe for the handler and personnel involved in carcass disposal; and
- inflicts minimal physiological and psychological stress on the investigator and potential onlookers.

Additional references:

American Association of Zoo Veterinarians (2006) *Guidelines for Euthanasia of Nondomestic Animals*. Available through online order at: www.aazv.org

Canadian Council on Animal Care (in prep.) *CCAC guidelines on: laboratory animal procedures - adopted guidelines on euthanasia*. Ottawa ON: CCAC.

SLIDE 33



Planning for field procedures on wildlife must include contingency plans for euthanasia in case it is required. Information on techniques appropriate for the species should be researched, and necessary materials and equipment should be prepared in advance. Many recommended means of euthanasia for captive animals are not feasible in the field, but the challenges presented by field conditions do not lessen the ethical obligation to reduce pain and distress during euthanasia.

Humane euthanasia methods render the animal insensitive to pain, then cause cardiac and respiratory arrest. For this reason, pharmaceutical methods are often advised, but the use of pharmaceutical agents requires proper disposal of the contaminated carcass. Any animal euthanized in the field that may contain residues of toxic chemicals (euthanasia agents or immobilizing drugs) should be carefully disposed of, as they may enter into the food chain with potentially severe consequences. For example, a non-steroidal anti-inflammatory drug (NSAID) used in domestic mammals entered the food chain in India and Western Africa, resulting in the devastation of several species of vultures. Acceptable disposal methods include incineration or liming the carcass, followed by burying it in a hole deep enough to discourage scavengers. Prior to disposal of carcasses in the field, investigators should determine the suitability of euthanized animals for preparation and use as study or teaching specimens with accompanying relevant information.

Physical Methods: These techniques, when properly applied, kill rapidly and cause minimal stress. They may offer a practical solution for field euthanasia of various sized birds and prevent pharmaceuticals from entering the food chain.

Blunt force: This method can be used on most birds and may be particularly useful for larger birds. This method requires securely holding the bird in an ice-cream cone grip, then rapidly and firmly bringing the head down on a hard surface (e.g., a rock). This method is

effective in rendering the bird unconscious and/or dead. To ensure death, cervical dislocation should immediately follow the blunt force trauma.

Cervical Dislocation: This method is used for birds under 1 kg. This technique involves quickly stretching the neck, severing the spine. The neck should never be twisted, but pulled in a straight line away from the body. This technique is easily learned and can be used on birds as large as pheasants or small geese.

Decapitation: This technique is only acceptable for very small species.

Gunshot: While a shot to the brain produces a quick and humane death, it should only be attempted when the animal is restrained (NOT by a human being) or as a last ditch effort for a free-ranging or escaped bird. Under the latter conditions, a successful shot to the brain may be difficult. Therefore, a shot to the heart and lung area may be more appropriate. This must be performed by skilled personnel with a firearms permit.

Pharmaceutical Methods: Investigators performing chemical euthanasia are encouraged to take a course offered by the Canadian Association of Zoo and Wildlife Veterinarians (www.cazwv.org/workshops.htm).

Injected pharmaceuticals: These agents should be administered intravenously at the correct dosage, with added sedation as needed to decrease fear and distress. Pre-anaesthetics (Ketamine, Xylazine and others) can be given by intramuscular injection to birds to facilitate euthanasia by another method. These drugs should not be used as sole euthanasia agents. There are potentially fatal toxic effects to scavenging animals consuming carcasses, so appropriate disposal of the carcass is required.

Inhaled gases: These are useful agents for euthanasia of small species when intravenous injection is difficult, but euthanasia with inhaled gases is slow because the inhaled gas must reach a certain concentration in the lungs to take effect. A closed chamber to hold the gas is needed, and personnel safety must be considered. Care should be taken when using euthanasia chambers because overcrowding or mixing of species can cause severe apprehension and psychological stress. The liquid state of most inhalant anaesthetics is irritating, so animals should only be exposed to vapours. Volatile anaesthetics are unsuitable for birds that have the ability to hold their breath for long periods of time (e.g., diving or burrowing species). Examples of inhaled gases include carbon monoxide, carbon dioxide and various anaesthetics.

Additional references:

Friend M., Franson J.C. & Ciganovich E.A. (eds.) (1999) *Field Manual of Wildlife Disease — General Field Procedures and Diseases of Birds*. Washington, DC: U.S. Department of the Interior and U.S. Geological Survey. Available at: www.nwhc.usgs.gov/publications/field_manual

SLIDE 34

Physical Risks: Many birds are capable of inflicting severe and even fatal injuries to the most experienced of handlers. It is therefore necessary to ensure adequate training for all researchers. Training should include the types of dangers posed by the species that will be handled and the way protective equipment must be used. For example, leather gloves are appropriate when handling larger raptor species such as the larger owls, hawks and eagles. Protective eye wear is appropriate for such species as the heron family, loons, grebes and cormorants. Their beaks are capable of creating severe wounds; however, it is their potential for causing eye and facial damage that is most dangerous. Knowing the differences between groups of birds is key: in the case of large raptorial birds, the talons must be controlled first, then the head; whereas with herons, loons, grebes and cormorants, the beak must be controlled immediately. Swans are another species capable of inflicting many injuries.

All species capable of inflicting injury should be managed by two handlers, particularly if the features capable of inflicting injury cannot be easily controlled (e.g., beaks and long necks). Physical risks are not confined to the handler. Care must be taken to ensure the bird is not injured while handlers try to control it. Depending on the species, covering the head and reducing the bird's vision can have a calming effect.

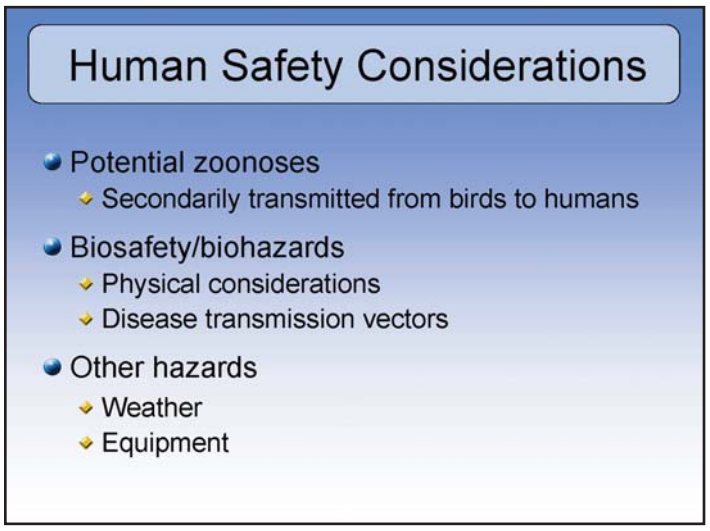
Birds defending their nests during nest checks may pose a risk to the research team. Use of protective head gear and thick jackets during nest checks must provide the necessary protection for researchers but not cause injury to the defending bird. In some cases, protective earwear may also be necessary. Where hearing is restricted, the research team should have pre-arranged communication signals to ensure safety.

Many birds and insects live in close proximity. When necessary (for example, in seasons when West Nile virus is active), field personnel should use either protective clothing or repellent applications to reduce the risk of bites. However, repellents should not be used if researchers are directly handling birds.

Chemical risks: Care must be taken to ensure safe handling practices for all chemicals. Any pharmaceuticals must be kept in appropriate containers and handled only after training and legal requirements are met. Spills must be avoided at all times. All chemicals, especially drugs, should be carried in crush-proof, leak-proof containers, and stored with absorbent material. Drugs should always be cushioned. The protocol should outline emergency procedures in case of spills, and these must be understood by all field personnel. Hazards exist not only to the research personnel, but also to the wildlife involved and the local environment. All safety data sheets must be read and carried for reference when han-

dling any hazardous material. Where necessary, reversal agents or drugs should be available, and medical centers identified in case of an emergency.

SLIDE 35



Zoonoses: Infections that can be transmitted from animals to humans are referred to as zoonoses. For most people, avian diseases do not pose a serious threat; however, those working with birds should be aware of this possibility and seek medical assistance if necessary. A variety of diseases are transmittable from birds to humans, including chlamydiosis, salmonellosis, tuberculosis and colibacillosis. Emergent diseases such as avian influenza must also be kept in mind. Investigators should be aware of any zoonotic potential in their region. It is important for all investigators to have current tetanus vaccinations and to consider rabies pre-exposure vaccinations should their field work involve potential contact with high risk mammals (e.g., bats, skunks, raccoons, foxes and domestic animals). Any illness that cannot be readily explained, especially those which appear unusual or persistent, should be followed up with medical attention, and the health care provider should be informed of any recent animal contact. Field workers should also take appropriate precautions against mosquito- and tick-transmitted diseases, such as eastern equine encephalitis virus, west Nile virus and Lyme disease. More information is available at edis.ifas.ufl.edu/PS019 and www.prbo.org/cms/docs/birdflu/PRBOBirdhandlingGuide.pdf.

Biosecurity: Investigators should familiarize themselves with the known biohazards specific to the study species. Where there is a potential for zoonotic transmission, the investigator must ensure that all team members are informed about the possible routes of disease transmission and exposure, and are trained in the use of protective equipment, medical interventions and safety procedures. Protective clothing must be provided and disposed of appropriately to minimize spread of disease or contamination. The use of footbaths may be recommended, especially in a captive facility.

If unusual numbers of dead or sick wildlife are observed, this should be reported to appropriate authorities (i.e. provincial/territorial wildlife offices, Environment Canada/Canadian Wildlife Service offices, Canadian Cooperative Wildlife Health Centre). Within Environment Canada, there is a Significant Event Notification form and procedure, and Incident Reporting Forms available through the Canadian Cooperative Wildlife Health Centre (CCWHC) website (http://wildlife1.usask.ca/). In the case of an outbreak of a known wildlife disease (especially a zoonotic disease or a notifiable disease for domestic animals), routine bird handling procedures should be suspended unless they are specifically part of a disease investigation or carcass clean-up.

In the interest of human health and safety, it is important that all wildlife that die from unknown causes in the field or in holding facilities undergo a post-mortem examination by the Canadian Cooperative Wildlife Health Centre to determine the cause of death. Results will be reported to the submitter and will be entered into the national database for wildlife disease (important for surveillance for diseases such as West Nile Virus and Avian Influenza). Depending on the post-mortem results, it may be necessary to obtain medical assistance to protect personnel from diseases and parasites.

For biosafety and other bird handling information, see http://infolane.ncr.ec.gc.ca and http://www.phac-aspc.gc.ca/influenza/fs-hwb-fr-mos_e.html. For submission of wildlife carcasses to CCWHC, see http://wildlife1.usask.ca/en/contact_info.php .

Weather: Local weather reports must be followed daily, and precautions must be taken in case of potential extreme weather events, including appropriate clothing and equipment to meet any potential hazard. These must be in working condition and appropriate for the region. It is recommended that the location of staff in the field be known at all times, and that all movement plans are recorded with the field camp at the start of each day (if applicable). An emergency plan should be in place to cover any potential weather-related contingencies, which may include ice, hail, flash flooding, tornadoes, micro-burst storms, thunderstorms, forest fires or wildfires, extremes of cold or heat, and high winds. The investigator must ensure that every member of the research team understands that human life is a top priority.

Equipment: Investigators should ensure that they are familiar and comfortable with their equipment, as this reduces the likelihood of injury. Knowing what hazards are possible when working in the field is a must. For example, mist-netting over water or cannon netting flocks of shorebirds near water may represent a human drowning hazard should entanglement occur. Knives and firearms should always be properly stored and well-maintained to prevent injury.

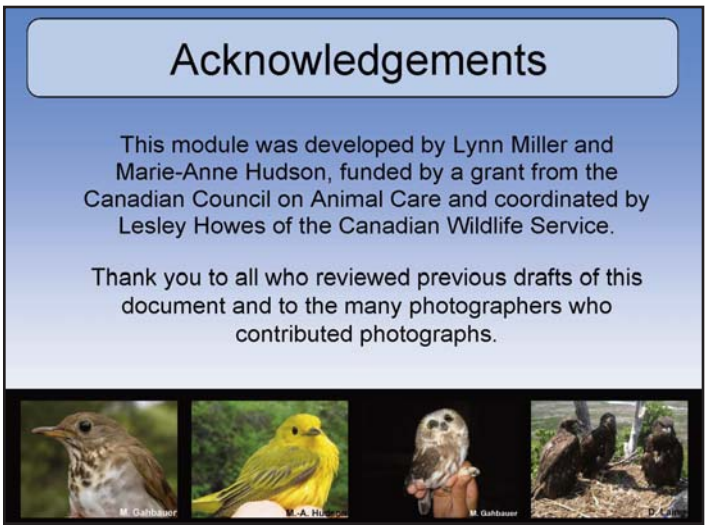
SLIDE 36

This module is an introduction to the theoretical training required before beginning any research with wild birds. Investigators must receive practical training prior to carrying out their research protocol. There are many places to get practical, theoretical and apprentice-type training.

The following agencies/organizations either provide both theoretical and practical training or provide contact information for such training:

- Bird-banding stations (list of stations available through the Canadian Migration Monitoring Network www.bsc-eoc.org/national/cmmn.html)
- Universities
- North American Banding Council (www.nabanding.net/nabanding)
- International Wildlife Rehab Council (www.iwrc-online.org)
- Canadian Association of Zoo and Wildlife Veterinarians (www.cazwv.org)

SLIDE 37



SLIDE 38

Notes:

This is meant to be used as a printable handout for references cited within this module, as well as additional references.

Slide 6

Animal Behavior Society (1986) Guidelines for the use of animals in research. *Animal Behaviour* 34:315-318.

Emlen S.T. (1993) Ethics and experimentation: hard choices for the field ornithologist. *Auk* 110:406- 409.

Friend M., Towell D.E., Brownell R.L.Jr., Nettles V.F., Davis D.S. & Foreyt W.J. (1994) Guidelines for the proper care and use of wildlife in field research. In: *Research and Management Techniques for Wildlife and Habitats*, 5th ed. (ed. T. Bookhoudt), pp. 96-105. Bethesda, MD: The Wildlife Society.

Gaunt A.S. & Oring L.W. (1999) *Guidelines to the Use of Wild Birds in Research*, 2nd ed. 66 pp. The Ornithological Council.

Peck F.R. & Simmonds R.C. (1995) Understanding animal research regulations: obligations of wildlife departments and field researchers. *Wildlife Society Bulletin* 23:279-282.

Slide 7

Gauthier C. & Griffin G. (2005) Using animals in research, testing and teaching. *OiE Scientific and Technical Review* 24:735-45.

Griffin G., Stokes W.S., Pakes S.P. & Gauthier C. (2004). The ICLAS/CCAC International Symposium on Regulatory Testing and Animal Welfare. *Alternatives to Laboratory Animals (ATLA)* 32: 707-712.

National Centre for the Replacement, Refinement and Reduction of Animals in Research: http://www.nc3rs.org.uk

Slide 14

Bloom P.H., Clark W.S. & Kidd J.W. (2007) Captive breeding for research and release. In: *Raptor Research and Management Techniques* (eds. D.M. Bird & K.L. Bildstein). Surrey, BC: Hancock House Publishers, Ltd. In Press.

Bub H. (1995) *Bird Trapping and Bird Banding: A Handbook for Trapping Methods All Over the World*. New York NY: Cornell University Press.

Day G.I., Schemnitz S.D. & Taber R.C. (1980) Capturing and marking wild animals. In: *Wildlife Management Techniques Manual* (ed. S.D. Schemnitz), pp. 61-88. Washington DC: The Wildlife Society.

Taber R.D. & Cowan I.M. (1969) Capturing and marking wild animals. In: *Wildlife Management Techniques*, 3rd ed. (ed. R.H. Giles), pp. 277-317. Washington DC: The Wildlife Society.

Slide 15

Keyes B. & Grue C. (1982) Capturing birds with mist nets: a review. *North American Bird Bander* 7(1): 2-14.

Slide 18

North American Banding Council (2001) *North American Bird Banding Manual*, vol 1. Available at: www.pwrc.usgs.gov/BBL/manual/manual.htm

Ralph C.J. (2005) The body grasp technique: a rapid method of removing birds from mist nets. *North American Bird Bander* 30: 65-70. Available at: www.fs.fed.us/psw/topics/wildlife/birdmon/landbird/body_grasp.pdf

Slide 21

Gratto-Trevor C.L. (2004) *The North American Bander's Manual for Banding Shorebirds*. North American Banding Council.

Harper R.G. & Neill A.J. (1990) Banding technique for small nestling passerines. *Journal of Field Ornithology* 61:212-213.

McCracken J.L., Enright D., Sheppard E.D., Cappelman J. & Dunn E. (1999) *The Canadian Bird Bander's Training Manual*. 114 pp. Canadian Wildlife Service, Environmental Conservation Services, Technical Report Series No. 275. National Wildlife Research Centre .

North American Banding Council (2001) *The North American Banders' Manual for Banding Passerines and Near Passerines*. North American Banding Council.

North American Banding Council (2001) *The North American Banders' Study Guide*. North American Banding Council.

North American Banding Council (2001) *North American Bird Banding Manual*, vol 1. Available at: www.pwrc.usgs.gov/BBL/manual/manual.htm.

Slide 23

Arnold K.E., Owens I.P.F. & Marshall N.J. (2002) Fluorescent signaling in parrots. *Science* 295:92.

Calvo B. & Furness R.W. (1992) A review of the use and effects of marks and devices on birds. *Ringing and Migration* 13:129-151.

Hausmann F., Arnorld K.E., Marshall N.J. & Owens I.P.F. (2003) Ultraviolet signals in birds are special. *Proceedings of the Royal Society B* 270: 61-67.

Kennard J.H. (1961) Dyes for color marking. *Bird-Banding* 32:228-229.

Marion W.R. & Shamis J.D. (1977) An annotated bibliography of bird marking techniques. *Bird-Banding* 48:42-61.

Neitfeld M.Y., Barrett M. & Silvy N. (1996) Wildlife marking techniques. In: *Research and Management Techniques for Wildlife and Habitats* (ed. T.A. Bookhout), pp. 140-168. The Wildlife Society. Kansas: Allen Press.

Paton P.W. & Pank L. (1986) A technique to mark incubating birds. *Journal of Field Ornithology* 57:232-233.

Sherwin C.M. & Devereux C.L. (1999) Preliminary investigations of ultraviolet-induced markings on domestic turkey chicks and a possible role in injurious pecking. *British Poultry Science* 40:429–433.

Slide 24

Amlaner C.J.Jr. & MacDonald D.W. (eds.) (1980) *A Handbook of Biotelemetry and Radio Tracking*. Oxford: Pergamon Press.

Cochran W.W. (1980) Wildlife telemetry. In: *Wildlife Management Techniques*, 4th ed. (ed. S.D. Schemnitz), pp. 507-520. Washington DC: The Wildlife Society.

Dougill S.J., Johnson L., Banks P.C., Goltz D.M., Wiley M.R. & Semones J.D. (2000) Consequences of antenna design in telemetry studies of small passerines. *Journal of Field Ornithology* 71(3):385-388.

Karl B.J. & Clout M.N. (1985). An improved radio transmitter harness for birds, with a weak link to prevent snagging. *Journal of Field Ornithology* 58:73-77.

Kenward R.E. (1987) *Wildlife Radio Tagging*. London: Academic Press.

Slide 26

Dorrestein G.M., Blaauboer B.J., Miltenburg N.A., & Deley P.P. (1978) A modified method of blood sampling from birds. *Lab Animal* 12:193-194.

Hoysak D.J. & Weatherhead P.J. (1991) Sampling blood from birds – a technique and an assessment of its effect. *Condor* 93: 746–752.

Slide 27

Carlisle J.D. & Holberton R.L. (2006) Relative efficiency of fecal versus regurgitated samples for assessing diet and the deleterious effects of a tartar emetic on migratory birds. *Journal of Field Ornithology* 77: 126–135.

Diamond A.W., Fayad V.C., & McKinley P.S. (In press) An improved emetic for wild birds: Ipecac. *Journal of Field Ornithology*. Accepted 11 July 2007.

Fridolfsson A.-K. & Ellegren H. (1999) A simple and universal method for molecular sexing of non-ratite birds. *Journal of Avian Biology* 30:116-221.

Slide 28

Abou-Madi N. (2001) Avian anesthesia. *Veterinary Clinics of North America; Exotic Animal Practice* 4(1):147-167.

Elzanowski A. & Abs M. (1991) Pain and stress in birds. In: *Acta XX Congressus Internationalis Ornithologici*. pp. 1901-1940. Christchurch, New Zealand, 1990. Wellington: Ornithological Congress Trust Board.

Gentle M.J. (1992) Pain in birds. *Animal Welfare* 1:235-247.

Heard D.J. (1997) Anesthesia and analgesia. In: *Avian Medicine and Surgery* (eds. R.B. Altman, S.L. Clubb, G.M. Dorrestein & K. Quesenberry). pp. 807-827. Philadelphia: W. B. Saunders.

Lewis J. (2004) Field use of isoflurane and air anesthetic equipment in wildlife. *Journal of Zoo and Wildlife Medicine* 35:303-311.

Machin K.L. (2005) Avian pain: physiology and evaluation. *Compendium on Continuing Education for the Practicing Veterinarian* 27:98-109.

Machin K.L. (2005) Controlling avian pain. *Compendium on Continuing Education for the Practicing Veterinarian* 27:299-308.

Machin K.L. (2005) Avian analgesia. *Seminars in Avian and Exotic Pet Medicine* 14: 236-242.

Machin K.L. (2004) Waterfowl anesthesia. *Seminars in Avian and Exotic Pet Medicine* 13:206-212.

Paul-Murphy J. & Ludders J. (2001) Avian analgesia. *Veterinary Clinics of North America; Exotic Animal Practice* 4(1):35-45.

Slide 32

American Association of Zoo Veterinarians (2006) *Guidelines for Euthanasia of Nondomestic Animals*. Available through online order at: www.aazv.org/

Canadian Council on Animal Care (in prep.) *CCAC guidelines on: laboratory animal procedures – adopted guidelines on euthanasia*. Ottawa ON: CCAC.

Slide 33

Friend M., Franson J.C. & Ciganovich E.A. (eds.) (1999) *Field Manual of Wildlife Disease — General Field Procedures and Diseases of Birds*. Washington DC: U.S. Department of the Interior and U.S. Geological Survey. Available at: www.nwhc.usgs.gov/publications/field_manual

Additional References:

Bliss D. (in prep.) *Significant Event Notification to be used by EC/CWS when a wild bird die-off is detected*.

Braun C.E. (ed.) (2005). *Techniques for Wildlife Investigations and Management*, 6th ed. Bethesda MD: The Wildlife Society.

Gaunt A.S. & Oring L.W. (eds.) (1997) *Guidelines to the Use of Wild Birds in Research*, 2nd ed. 66 pp. The Ornithological Council. Available at: www.nmnh.si.edu/BIRDNET/GuideToUse/Guidelines_2d_edition.pdf